NOTE

This Microfiche meets the quality requirements of the American National Standard for Microfiche of Documents (ANSI PH5.9-1975). However, because of imperfections in the document from which it was made, it contains images that are illegible or difficult to read. The source document for this microfiche is the best copy that could be obtained prior to filming.

CIS Congressional Information Service, Inc
Washington, D.C.

ASSESS POTENTIAL GAINS AND DRAWBACKS OF CIVILIAN SPACE COOPERATION WITH THE SOVIETS

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
SPACE SCIENCE AND APPLICATIONS

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

FIRST SESSION

JULY 30 AND 31, 1985

[No. 23]

Printed for the use of the
Committee on Science and Technology

U.S. GOVERNMENT PRINTING OFFICE
52-457 O WASHINGTON : 1985

H701-85

COMMITTEE ON SCIENCE AND TECHNOLOGY

DON FUQUA, Florida, *Chairman*

ROBERT A. ROE, New Jersey
GEORGE E. BROWN, JR., California
JAMES H. SCHEUER, New York
MARILYN LLOYD, Tennessee
TIMOTHY E. WIRTH, Colorado
DOUG WALGREN, Pennsylvania
DAN GLICKMAN, Kansas
ROBERT A. YOUNG, Missouri
HAROLD L. VOLKMER, Missouri
BILL NELSON, Florida
STAN LUNDINE, New York
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
NORMAN Y. MINETA, California
MICHAEL A. ANDREWS, Texas
BUDDY MacKAY,** Florida
TIM VALENTINE, North Carolina
HARRY M. REID, Nevada
ROBERT G. TORRICELLI, New Jersey
FREDERICK C. BOUCHER, Virginia
TERRY BRUCE, Illinois
RICHARD H. STALLINGS, Idaho
BART GORDON, Tennessee
JAMES A. TRAFICANT, JR., Ohio
MANUEL LUJAN, JR.,* New Mexico
ROBERT S. WALKER, Pennsylvania
F. JAMES SENSENBRENNER, JR., Wisconsin
CLAUDINE SCHNEIDER, Rhode Island
SHERWOOD L. BOEHLERT, New York
TOM LEWIS, Florida
DON RITTER, Pennsylvania
SID W. MORRISON, Washington
RON PACKARD, California
JAN MEYERS, Kansas
ROBERT C. SMITH, New Hampshire
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
WILLIAM W. COBEY, JR., North Carolina
JOE BARTON, Texas
D. FRENCH SLAUGHTER, JR., Virginia
DAVID S. MONSON, Utah

HAROLD P. HANSON, *Executive Director*
ROBERT C. KETCHAM, *General Counsel*
REGINA A. DAVIS, *Chief Clerk*
JOYCE GROSS FREIWALD, *Republican Staff Director*

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS

BILL NELSON, Florida, *Chairman*

GEORGE E. BROWN, JR., California
MICHAEL A. ANDREWS, Texas
ROBERT G. TORRICELLI, New Jersey
BART GORDON, Tennessee
JAMES H. SCHEUER, New York
HAROLD L. VOLKMER, Missouri
NORMAN Y. MINETA, California
RALPH M. HALL, Texas
ROBERT S. WALKER, Pennsylvania
JAN MEYERS, Kansas
ROBERT C. SMITH, New Hampshire
JOE BARTON, Texas
D. FRENCH SLAUGHTER, JR., Virginia
DAVID S. MONSON, Utah

RADFORD BYERLY, *Staff Director*
ROSELEE ROBERTS, *Technical Consultant*

---

*Ranking Republican Member.
**Serving on Committee on the Budget for 99th Congress.

CONTENTS

WITNESSES

	Page
July 30, 1985:	
Hon. Spark M. Matsunaga, a U.S. Senator from the State of Hawaii	1
James M. Beggs, Administrator, National Aeronautics and Space Administration	24
John Andelin, Office of Technology Assessment	41
Nancy Lubin, Project Director, Office of Technology Assessment	42
July 31, 1985:	
Charles Horner, Deputy Assistant Secretary of State for Science and Technology, Department of State	54
Donald K. Slayton, Space Services, Inc. of America	66
Vance D. Brand, Lyndon B. Johnson Space Center, National Aeronautics and Space Administration	73
John Simpson, University of Chicago, laboratory of astrophysics and space research; Bradford Smith, department of planetary sciences, University of Arizona; Harold Masursky, senior scientist, U.S. Geological Survey; and Harold P. Klein	84

ASSESS POTENTIAL GAINS AND DRAWBACKS OF CIVILIAN SPACE COOPERATION WITH THE SOVIETS

TUESDAY, JULY 30, 1985

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, DC.

The subcommittee met, pursuant to notice, at 12:45 p.m., in room 2325, Hon. Bill Nelson (chairman of the subcommittee) presiding.

Present: Representatives Nelson, Andrews, Walker, Smith, and Slaughter.

Mr. NELSON. The committee will come to order. Senator, since I had to delay to go vote, rather than hold you up with an opening statement, I will defer until later in the afternoon, in which I have a number of comments that I want to make. But as a courtesy to you, I want you to have the opportunity to get on as quickly back to the Senate floor as is possible. So, we'll be delighted to go on and hear your testimony.

STATEMENT OF HON. SPARK M. MATSUNAGA, A U.S. SENATOR FROM THE STATE OF HAWAII

Mr. MATSUNAGA. Thank you very much, Mr. Chairman and distinguished members of the subcommittee. I thank you for inviting me to testify before you today to discuss the opportunities for U.S.-U.S.S.R. cooperation in space. I had the pleasure and honor to serve as a Member of the House of Representatives for 14 years before I was elected to the U.S. Senate, and my memories of those 14 years are still very warm. But I still haven't been able to figure out what some of my supposedly good friends meant when upon congratulating me, upon being elected to the Senate, they said, you know, Sparky, by going to the other body, you improve the quality of both bodies.

Nevertheless, those bonds still continue, Mr. Chairman, especially with the House Science and Technology Committee. As acting chairman of the Research and Development Subcommittee of the Senate Energy Committee, I work closely with your committee on renewable energy legislation in particular. And I think we accomplished a great deal to launch new industries that I believe will one day make our Nation energy independent for all time.

In that same spirit, Mr. Chairman, I would like to congratulate you for your leadership in encouraging public discussion on the issue of U.S.-U.S.S.R. cooperation, and to offer all the assistance I

can. The significance of this issue is vastly underrated. Its outcome will determine the character of a whole new age. Perhaps of greater significance is that its success will mean a peaceful working relationship between the two nuclear armed superpowers.

Your hearings come at a critical juncture, and Congress and the public should be grateful for the initiative you have shown.

In 1984, I introduced Senate Joint Resolution 236, with Senators Mathias and Pell as original cosponsors, calling for renewal of the 5-year U.S.-U.S.S.R. space cooperation agreement first negotiated in 1972, renewed in 1977, and allowed to lapse in May 1982 in response to the declaration of martial law in Poland.

A companion version was later introduced in the House by Congressman Mel Levine. Both bodies passed Senate Joint Resolution 236 unanimously and it was signed into law last October by President Reagan, culminating a 2-year effort that began with the unsuccessful introduction of identical legislation in 1983.

Under the terms of Senate Joint Resolution 236, President Reagan is committed to seek to renew the space cooperation agreement at the earliest practicable date. More importantly, perhaps, the 1983 and 1984 resolutions have served as vehicles for giving space cooperation the attention it deserves inside the Government and among the public.

Currently, the Senate is considering two resolutions I have introduced that pursue the issue further. Senate Joint Resolution 46 calls upon the President, as part of his effort to renew the space cooperation agreement, to direct the Administrator of NASA to, first, explore the opportunities for coordinating already scheduled scientific missions by the U.S.S.R. to the Mars moon Phobos in 1988 and by the United States to Mars in 1990; and, second, prepare a report examining the opportunities for coordinating future Mars related activities.

Senate Joint Resolution 177, which I have introduced with Senator Jake Garn, calls for an—Jake Garn being one of those Senators who flew in space actually, and not like some of us who are in space while on the ground—calls for an International Space Year, or ISY, in 1992, which happens to be the 35th anniversary of the International Geophysical Year, or IGY, the 500th anniversary of the discovery of America by Columbus, and the 75th anniversary of the Russian Revolution, which the Soviets expected to commemorate with major space activities.

I am delighted, Mr. Chairman, that you and Congressman Walker have introduced companion legislation in the House. Senator Garn and I look forward to working with you to ensure speedy passage.

Senate Joint Resolution 46, the Mars resolution, was conceived with two purposes in mind. First, it responds to concerns expressed to me by American space scientists that time is running out on the limited opportunities remaining for coordinating the two upcoming Mars missions. In that connection, it is important to note that had a space cooperation agreement been in effect, those two missions might even have been arranged for the same year with maximum complementarity.

As it is, only a brief overlap of a few weeks will occur between the life of the Soviet mission and the arrival of our own. But there

are still opportunities worth exploring that I expect your scientist witnesses will spell out in greater detail tomorrow.

Second, the resolution asks for a report on future Mars possibilities so that the next time around, we'll know what we might be missing. That second point is of particular significance for your committee, in my view. Because they concern U.S.-U.S.S.R. relations, my resolutions have been referred to the Senate Foreign Relations Committee.

While that committee's jurisdiction is entirely appropriate, there is a vital aspect of this issue which properly belongs within the jurisdiction of the Space Subcommittees in both Houses of Congress; members of which are uniquely competent to assess. It can be summarized in a series of questions.

What are the long term requirements of space exploration? What are the potential costs, especially as missions become more complex in size and scope? In what instance might cooperation be not merely desirable but necessary? Does it make sense to race the Russians to Mars? And after that, Jupiter? Neptune? The next galaxy?

If it does not make sense, in what ways—I consider this extremely important—can joint missions be designed so that our contribution is salvageable at any point in the project's development, in the event that foreign policy considerations force withdrawal?

There are numerous ways in which your committee can take the lead in adding a space age dimension to discussions of space cooperation. The public and policymakers need a broader context for this issue that you are uniquely qualified to provide.

As you know, Mr. Chairman, I have been an early and strong advocate of an international manned mission to Mars. I don't suggest it as a first step in resuming U.S.-U.S.S.R. cooperation. That's far too much to expect so soon. But I still think it's important to talk about it because it reminds us of what's over the horizon. It seems to me that too much of the time we've been backing into the space age with our eyes fixed firmly on the ground.

For instance, the shuttle was originally conceived by Wernher von Braun in the 1950's as part of a grand design for a Mars mission that included a space station. That package was rejected in 1961 in favor of a crash program to place the first human on the Moon, strictly for foreign policy reasons. The Mars mission package was rejected again in 1969 for budgetary reasons, and instead we wound up only with the shuttle and are just now moving toward a space station.

The economics of the shuttle and the space station would make a lot more sense if we recognized that their primary function is not to launch satellites or conduct experiments, but to serve as long term infrastructure for interplanetary exploration and settlement; in much the same manner that federally financed roads, trails and outposts opened the American frontier to the vast long term benefit of American trade and commerce.

Until we recognize that the space age is the age of long lead times, we will never begin to understand its economics, and the benefits it offers, and the policies it requires.

Discussion of a Mars mission forces us to consider short term programs in a more expansive context. Is an international mission

the most practical way to go to Mars? If so, and recognizing that space stations will serve as launch pads for interplanetary flight, to what extent is space station design taking into account the communications and docking compatibilities that would be required in the event of joint activity?

Unless such questions are addressed now, we may face unnecessary costs or even foreclose extraordinary opportunities should major joint activity become feasible down the road. If you would care to introduce legislation proposing that appropriate contingency studies for at least a minimum of space station coordination be undertaken, I would be delighted to support a companion measure in the Senate. These are the kinds of outward looking steps that are necessary, I believe, to prepare for space age eventualities.

My proposal for an International Space Year in 1992, or ISY, was conceived with the need to engineer a transition to a space age context very much in mind. Now I realize that committed Americans, myself included, are unhappy with what followed the Russian Revolution, as a certain number of Russians are no doubt unhappy with what followed the discovery of America. But it implies no endorsement of events in 1917 to recognize that the Soviets can be expected to commemorate them with major space activities, especially since 1992 is also the 35th anniversary of Sputnik, which was launched during the IGY.

Some scientists suggest that their single minded involvement with long duration flight points toward a major manned mission in 1992, perhaps even to the vicinity of Mars. The launching of a multipod space station complex seems to be more likely to me.

In any event, it would be embarrassing to the extreme for us to see the U.S.S.R. launch a dramatic space mission in 1992 while we celebrate the discovery of America with 15th century costumed ceremonies. Our first option is to ignore those possibilities and risk a national crisis. The second option is to seek to match and exceed activities whose precise nature is unknown to us.

The third option, which I believe best serves the national interest, is to approach the Soviets in advance and say, "1992? No Sputniks. No surprises. This time let's do it right. Let's coordinate in advance and involve as many other nations as we can."

The space age got off on the wrong foot in 1957, Mr. Chairman and members of the subcommittee, and 1992 offers a unique opportunity to set it right. If we don't act now, we might be faced once again with pressures to launch crash programs for national prestige that relate only incidentally to the rational requirements of space exploration. It would be a mistake to repeat that wasteful process.

An ISY in the 1992–95 timeframe would allow space activities in that period to unfold in a broader and less volatile international context. In that broader context, the only event to be officially commemorated would be the International Geophysical Year of 1957–58. Attempts to exploit 1992 for other narrower purposes would be condemned in advance by all participants. Potential crises would be averted.

As Senator Garn and I stated in our recent "Dear Colleague" letter, to solicit cosponsors for Senate Joint Resolution 177, I quote, "We believe American leadership in encouraging an ISY would be

welcomed worldwide, and that such an event would be a historic milestone in humanity's advance into space."

I am avoiding discussion of the scientific benefits to be gained from cooperation with the Soviets because I'm sure they will be discussed with greater authority by your scientist witnesses. However, I would like to offer, for the record, a statement issued on July 17 by Senator Pell, Senator Mathias, and myself in connection with the release of an Office of Technology Assessment, OTA, report on U.S.-U.S.S.R. space cooperation which we had earlier requested. It alludes to testimonies by scientists received by the Senate Foreign Relations Committee last fall.

Finally there is the issue of technology transfer. It is a legitimate issue when approached rationally. Unfortunately, it's too often approached mystically. During the past 3 years I have discussed technology transfer with many experts. One of them is Gen. Lew Allen, Director of the Jet Propulsion Laboratory, former Air Force Chief of Staff, and Director of the National Security Agency. Besides his many other accomplishments, General Allen holds a doctorate in physics and worked for many years on weapons development. No one is more qualified to address the issue of technology transfer in space than he is.

I had the pleasure of hosting a private dinner meeting on space cooperation that General Allen attended more than a year ago. Afterward, I asked him to set his views in writing. I would like to make his previously unpublished communication available to your committee today. In it he refers to Senate Concurrent Resolution 16, the identical predecessor of Senate Joint Resolution 236. He endorses it. He also explains how cooperation can be resumed without risk of technology transfer by distinguishing between four different types of activities; one, data exchange; two, coordination of separate missions; three, exchange of instruments on separate missions; and four, joint missions.

General Allen points out that the first two categories involve no technology transfer, the third might in some instances, and the fourth needs to be examined carefully, but should not be ruled out. So, there is plenty of room for maneuver and, as General Allen points out, a great deal to be gained. We can start out with modest activities and build toward missions of gradually increasing complexity, as out national interests dictate.

As a first step, Mr. Chairman, I hope that President Reagan will take advantage of the upcoming summit in Geneva to seek to renegotiate the U.S.-U.S.S.R. space cooperation agreement, which he allowed to terminate in 1982. You will recall that the first agreement was the outgrowth of the Nixon-Brezhnev summit of 1972.

Such confidence building accords are traditionally a part of summit activity. And fortunately President Reagan already has endorsed Senate Joint Resolution 236. He has also come out in favor of expanded scientific exchanges with the Soviet Union, and has initiated a number of modest, but significant, steps in that direction.

NASA Administrator James Beggs, who I understand will be testifying today, has also been most consistent in his support of international cooperation in space, in keeping with the enlightened approach to his responsibilities that has earned him so much de-

served respect. Indeed, I would be surprised if the President did not bring up space cooperation at the Geneva summit meeting.

Perhaps our task is to support President Reagan's admirable efforts in whatever ways we can. Your hearing is an important contribution in that regard, and I would like to congratulate you again for convening it, and thank you again for granting me this opportunity to testify before you.

[The prepared statement of Senator Matsunaga follows:]

TESTIMONY BY THE HONORABLE SPARK M. MATSUNAGA
UNITED STATES SENATOR
AT A HEARING ON "U.S.-SOVIET CIVILIAN SPACE COOPERATION"
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
2325 Rayburn House Office Building
Washington, D. C.
Tuesday, July 30, 1985

Mr. Chairman, distinguished Subcommittee members, I thank you for inviting me to appear before you today to discuss the opportunities for U.S.-Soviet cooperation in space. I had the pleasure and honor to serve as a member of the House of Representatives for fourteen years, until I was elected to the Senate in 1976, and my memories of those years are warm and filled with respect for the institution and its members. Those bonds continue, Mr. Chairman, especially with the House Science and Technology Committee. As Acting Chairman of the Research and Development Subcommittee of the Senate Energy Committee, I worked closely with your Committee on renewable energy legislation in particular, and I think we accomplished a great deal in helping to launch new industries that I believe will one day make our nation energy independent for all time.

In that same spirit, Mr. Chairman, I would like to congratulate you for your leadership in encouraging public discussion on the issue of U.S.-U.S.S.R. space cooperation and to offer all the assistance I can. The significance of this issue is vastly under-rated. Its outcome will determine the character of a whole new age. Perhaps, of greatest significance is that its success will mean a peaceful working relationship between the two nuclear armed super powers. Your hearings come at a critical juncture and Congress and the public should be grateful for the initiative you have shown.

In 1984, I introduced Senate Joint Resolution 236, with Senators Mathias and Pell as original cosponsors, calling for renewal of the five year U.S.-U.S.S.R. space cooperation agreement first negotiated in 1972, renewed in 1977, and allowed to lapse in May 1982 in response to the declaration of martial law in Poland. A companion version was later introduced in the House by Congressman Mel Levine. Both bodies passed S.J. Res. 236 unanimously and it was signed into law last October by President Reagan, culminating a two-year effort that began with the unsuccessful introduction of identical legislation in 1983. Under the terms of S.J. Res. 236, President Reagan is committed to seek to renew the space cooperation agreement "at the earliest practicable date." More importantly, perhaps, the 1983 and 1984 resolutions have served as vehicles for giving space cooperation the attention it deserves inside the government and among the public.

Currently, the Senate is considering two resolutions I

have introduced that pursue the issue further.

Senate Joint Resolution 46 calls upon the President, as part of his effort to renew the space cooperation agreement, to direct the Administrator of NASA to (1) explore the opportunities for coordinating already-scheduled scientific missions by the U.S.S.R. to the Mars moon Phobos in 1988 and by the U.S. to Mars in 1990, and (2) prepare a report examining the opportunities for coordinating future Mars-related activities.

Senate Joint Resolution 177, which I have introduced with Senator Jake Garn, calls for an International Space Year, or ISY, in 1992, which happens to be the 35th anniversary of the International Geophysical Year, or IGY, the 500th anniversary of the discovery of America by Columbus, and the 75th anniversary of the Russian Revolution which the Soviets are expected to commemorate with major space activities. I am delighted, Mr. Chairman, that you and Congressman Walker have introduced companion legislation in the House. Senator Garn and I look forward to working with you to insure speedy passage.

S.J. Res. 46, the Mars resolution, was conceived with two purposes in mind. First, it responds to concerns expressed to me by American space scientists that time is running out on the limited opportunities remaining for coordinating the two upcoming Mars missions. In that connection, it is important to note that, had a space cooperation agreement been in effect, those two missions might even have been arranged for the same year, with maximum complementarity. As it is, only a brief overlap of a few weeks will occur between the life of the Soviet mission and the arrival of our own, but there are still opportunities worth exploring that I expect your scientist witnesses will spell out in greater detail tomorrow. Secondly, the resolution asks for a report on future Mars possibilities, so that, the next time around, we'll know what we might be missing.

That second point is of particular significance for your Committee in my view. Because they concern U.S.-U.S.S.R. relations, my resolutions have been referred to the Senate Foreign Relations Committee. While that Committee's jurisdiction is entirely appropriate, there is a vital aspect of this issue which properly belongs within the jurisdiction of the Space Subcommittees in both Houses of Congress, members of which are uniquely competent to assess. It can be summarized in a series of questions. What are the long-term requirements of space exploration? What are the potential costs, especially as missions become more complex in size and scope? In that instance might cooperation be not merely desirable but necessary? Does it make sense to race the Russians to Mars? And after that, Jupiter? Neptune? The next galaxy? If it doesn't make sense, in what ways -- I consider this extremely important -- can joint missions be designed so that our contribution is salvageable at any point in the project's development, in the event that foreign policy considerations force withdrawal? There are numerous ways in which your Committee can take the lead in adding a Space Age dimension to discussions of space cooperation. The public and

policymakers need a broader context for this issue that you are uniquely qualified to provide.

As you may know, I have been an early and strong advocate of an international manned mission to Mars. I don't suggest it as a first step in resuming U.S.-U.S.S.R. cooperation. That's far too much to expect so soon. But I still think it's important to talk about it because it reminds us of what's over the horizon. It seems to me that too much of the time we've been backing into the Space Age with our eyes fixed firmly on the ground.

For instance, the Shuttle was originally conceived by Werner Von Braun in the 1950s as part of a grand design for a Mars mission that included a space station. That package was rejected in 1961 in favor of a crash program to place the first human on the Moon, strictly for foreign policy reasons. The Mars mission package was rejected again in 1969 for budgetary reasons, and instead we wound up only with the Shuttle and are just now moving toward a Space Station. The economics of the Shuttle and the Space Station would make a lot more sense if we recognized that their primary function is not to launch satellites or conduct experiments but to serve as long-term infrastructure for interplanetary exploration and settlement, in much the same manner that federally-financed roads, trails and outposts opened the American frontier, to the vast long-term benefit of American trade and commerce. Until we recognize that the Space Age is the age of long lead times, we will never begin to understand its economics, the benefits it offers and the policies it requires.

Discussion of a Mars mission forces us to consider short-term programs in a more expansive context. Is an international mission the most practical way to go to Mars? If so, and recognizing that space stations will serve as launchpads for interplanetary flight, to what extent is space station design taking into account the communications and docking compatibilities that would be required in the event of joint activity?

Unless such questions are addressed now, we may face unnecessary costs or even foreclose extraordinary opportunities, should major joint activity become feasible down the road. If you would care to introduce legislation proposing that appropriate contingency studies for at least a minimum of space station coordination be undertaken, I would be delighted to support a companion measure in the Senate. These are the kinds of outward-looking steps that are necessary, I believe, to prepare for Space Age eventualties.

My proposal for an International Space Year in 1992, or ISY, was conceived with the need to engineer a transition to a Space Age context very much in mind. Now I realize that committed Americans, myself included, are unhappy with what followed the Russian revolution, as a certain number of Russians are no doubt unhappy with what followed the discovery of America. But it implies no endorsement of events in 1917 to recognize that

the Soviets can be expected to commemorate them with major space activities, especially since 1992 is also the 35th anniversary of Sputnik, which was launched during the IGY. Some scientists suggest that their single-minded involvement with long duration flight points toward a major manned mission in 1992, perhaps even to the vicinity of Mars. The launching of a multi-pod space station complex seems to me more likely.

In any event, it would be embarrassing to the extreme for the U.S.S.R. to launch a dramatic space mission in 1992 while we are celebrating the discovery of America with 15th century costumed ceremonies. Our first option is to ignore those possibilities and risk a national crisis. The second option is to seek to match and exceed activities whose precise nature is unknown to us. The third option, which I believe best serves the national interest, is to approach the Soviets in advance and say: "1992? No Sputniks. No surprises. This time, let's do it right. Let's coordinate in advance and involve as many other nations as we can."

The Space Age got off on the wrong foot in 1957, Mr. Chairman, and 1992 offers a unique opportunity to set it right. If we don't act now, we might be faced once again with pressures to launch crash programs for national prestige that relate only incidentally to the rational requirements of space exploration. It would be a mistake to repeat that wasteful process.

An ISY in the 1992-1995 time frame would allow space activities in that period to unfold in a broader and less volatile international context. In that broader context, the only event to be officially commemorated would be the International Geophysical Year of 1957-58. Attempts to exploit 1992 for other narrower purposes would be condemned in advance by all participants. Potential crises would be averted. As Senator Garn and I stated in our recent "Dear Colleague" letter to solicit co-sponsors for S.J. Res. 177, "we believe American leadership in encouraging an ISY would be welcomed worldwide and that such an event would be a historic milestone in humanity's advance into space."

I am avoiding discussion of the scientific benefits to be gained from cooperation with the Soviets because I'm sure they will be discussed with greater authority by your scientist-witnesses. However, I would like to offer for the record a statement issued on July 17 by Senator Pell, Senator Mathias, and myself in connection with the release of an Office of Technology Assessment (OTA) report on U.S.-U.S.S.R. space cooperation which we requested. It alludes to testimony by scientists received by the Senate Foreign Relations Committee last fall.

Finally, there is the issue of technology transfer. It is a legitimate issue when approached rationally. Unfortunately, it's too often approached mystically. During the past three years, I have discussed technology transfer with many experts.

One of them is General Lew Allen, Director of the Jet Propulsion Laboratory, former Air Force Chief of Staff and Director of the National Security Agency. Besides his many other accomplishments, General Allen holds a doctorate in physics and worked for many years on weapons development. No one is more qualified to address the issue of technology transfer in space than he is. I had the pleasure of hosting a private dinner-meeting on space cooperation that General Allen attended more than a year ago. Afterwards, I asked him to set his views in writing. I would like to make his previously unpublished communication available to your committee today. In it, he refers to S.Con. Res. 16, the identical predecessor of S.J. Res. 236. He endorses it. He also explains how cooperation can be resumed without risk of technology transfer by distinguishing between four different types of activity: (1) data exchange; (2) coordination of separate missions; (3) exchange of instruments on separate missions; (4) joint missions.

General Allen points out that the first two categories involve no technology transfer, the third might in some instances, and the fourth needs to be examined carefully but should not be ruled out. So there is plenty of room for maneuver and, as General Allen points out, a great deal to be gained. We can start out with modest activities and build toward missions of gradually increasing complexity as our national interests dictate.

As a first step, Mr. Chairman, I hope that President Reagan will take advantage of the upcoming summit in Geneva to seek to re-negotiate the U.S.-U.S.S.R. space cooperation agreement, which he allowed to terminate in 1982. You will recall that the first agreement was the outgrowth of the Nixon-Brezhnev summit in 1972. Such confidence-building accords are traditionally a part of summit activity, and fortunately President Reagan already has endorsed S.J. Res. 236. He has also come out in favor of expanded scientific exchanges with the Soviet Union and has initiated a number of modest but significant steps in that direction. NASA Administrator James Beggs has also been most consistent in his support of international cooperation in space, in keeping with the enlightened approach to his responsibilities that has earned him so much deserved respect. Indeed, I would be surprised if the President did not bring up space cooperation at the Geneva summit meeting. Perhaps our task is to support President Reagan's admirable efforts in whatever ways we can. Your hearing is an important contribution in that regard and I would like to congratulate you again for convening it and thank you for the opportunity to present my views.

# # #

Mr. NELSON. Thank you, Senator. I recall reading part of a report on the Apollo-Soyuz mission—if I recall, it was written by Mr. George Low, a former NASA official, in which he was discussing the question of technology transfer. And he said, that when you look, all said and done, in the confines in which they operated on the joint Russian-United States mission in 1975, that the technology was protected. The Russians protected their technology, the United States protected its technology.

What they did, though, was they learned about each other's mode of operating, and about each other's systems of operations. And he said, the fact that we are an open society, and that information is readily available, that in this joint venture that we really profited more than the Soviets, because we got an insight into how the Soviets operate and how they work.

The other thing that I recall a distinct impression—a couple of weeks ago we hosted, the Science and Technology Committee, hosted a reception for our three American astronauts and the two Soviet cosmonauts. And it was so obvious the personal affection that the five of them had for each other, and it was so obvious so many of the people who had worked on that program came here to the Hill and joined in, and hadn't seen each other for years, some of the Soviets hadn't seen the Americans and vice versa, and it was a warm reception, and it was gratifying.

Mr. MATSUNAGA. We had that same experience on the Senate side, Mr. Chairman.

Mr. NELSON. Oh, very fine.

Mr. MATSUNAGA. We had——

Mr. NELSON. Well, without objection, Gen. Lew Allen's letter will be entered and will be a part of the record. And without objection, unanimous consent is granted that the media and communications equipment are allowed to be here for purposes of recording this hearing.

[Material referred to follows:]

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91109
(818) 354-4321

JPL

1984 MAY 29 AM 3 38

May 25, 1984

Senator Spark M. Matsunaga
Senate Hart Office Building #109
2nd Street and Constitution Avenue, N.E.
Washington, DC 20510

Dear Senator Matsunaga,

I am writing in regard to Senate Concurrent Resolution 16 which you submitted and which has been referred to the Committee on Foreign Relations.

The Soviet Union has an active and productive program of planetary exploration for scientific purposes. At present they have two spacecraft orbiting Venus, called Venera 15 and 16, which are producing important radar observations of the surface of that planet. Soviet scientists have been reasonably cooperative with United States scientists by sharing the data from their ongoing mission. Such cooperation is important to us because we are building a spacecraft, Venus Radar Mapper, which will make more refined and more complete radar observations several years hence and it is clearly advantageous to understand fully the Soviet observations.

Next year, the Soviets plan to launch two more spacecraft to Venus which will continue past Venus to Halley's Comet. The United States plans to assist in tracking these spacecraft so that the position of the spacecraft and the observations of the comet from the spacecraft can be combined to assist the European spacecraft, Giotto, to rendezvous more accurately with the comet.

In the future, we and the Soviets are planning missions to Mars with apparently different but related objectives.

I mention these activities in the field of planetary exploration to make the point that I believe there is much potential for benefit to the United States from cooperation with the Soviet Union in space activities.

Jet Propulsion Laboratory
California Institute of Technology

Senator Matsunaga May 25, 1984

Cooperation in space can fall into four categories with increasing complexity.

1) Discussion and exchange of results (data, samples, photos, etc.) from space missions.

2) Discussion of mission plans in order to increase their complementarity, thereby increasing the total science return.

3) Sharing of experiments where we fly one of their instruments on one of our missions and vice versa.

4) Joint missions - in which planning, spacecraft development, operations and data analysis are done jointly.

NASA currently cooperates with the European Space Agency and with individual European nations in all four categories -- the highly successful IRAS mission in 1983 is a notable example of such coopperation. Under the prior agreement we've also cooperated with the USSR in all four categories in the past. Within the first two categories there are abundant opportunities for joint activities in space with the Soviets witout a technology transfer problem. Cooperation in the fourth category is certainly more difficult in the present climate, but cooperation in the first two categories, and possibly the third, would provide significant scientific return.

I personally believe that renewal of the previous agreement on space cooperation would be to our benefit and I offer my support and encouragement to the purpose of your resolution.

Sincerely,

Lew Allen

Mr. NELSON. Now, let me ask you. You mentioned——

Mr. MATSUNAGA. And, Mr. Chairman, while you're on the unanimous-consent request——

Mr. NELSON. Certainly, the joint statement.

Mr. MATSUNAGA. Yes, the joint statement of the committee also be included in the record.

Mr. NELSON. It's a part of the record.

[Material referred to follows:]

SPARK M. MATSUNAGA
HAWAII

WASHINGTON OFFICE
109 HART BUILDING
WASHINGTON, DC 20510

HONOLULU OFFICE
3104 FEDERAL BUILDING
HONOLULU, HI 96850

United States Senate

WASHINGTON, DC 20510

CHIEF DEPUTY
DEMOCRATIC WHIP

MEMBER
COMMITTEE ON ARMED
COMMITTEE ON ENERGY AND
NATURAL RESOURCES
COMMITTEE ON LABOR AND
HUMAN RESOURCES
COMMITTEE ON
VETERANS AFFAIRS

JOINT STATEMENT BY SENATORS CHARLES McC. MATHIAS,
SPARK MATSUNAGA AND CLAIBORNE PELL
ON THE OFFICE OF TECHNOLOGY ASSESSMENT REPORT
ON SPACE COOPERATION BETWEEN THE
UNITED STATES AND UNION OF SOVIET SOCIALIST REPUBLICS

The Office of Technology Assessment's (OTA) technical memorandum on "U.S.-Soviet Cooperation in Space" offers convincing evidence of the scientific benefits to be gained from renewing the U.S.-U.S.S.R. space cooperation agreement, which lapsed in 1982. This report reinforces the judgment last year of Congress in passing unanimously Senate Joint Resolution 236 calling for a renewal of that agreement. We were the original cosponsors of that measure, which President Reagan signed into law on October 30, 1984.

We are particularly impressed by the findings of the panel of 13 distinguished space scientists assembled by OTA to lay the foundation for this report. They have demonstrated beyond doubt that important scientific benefits accrued to the United States before we let the agreement lapse in 1982 and that those benefits would resume upon the agreement's renewal. If anything, the benefits would increase, as indicated by the testimony offered by Dr. Bernard F. Burke of the Massachusetts Institute of Technology, Chairman of the OTA panel. On September 13, 1984, at the Senate Foreign Relations Committee hearing on S. J. Res. 236, chaired by Senator Mathias, Dr. Burke presented the panel's findings as follows:

"In summary, we conclude the following:

"1. Important scientific interchanges continue today, demonstrating the willingness of U.S. and Soviet scientists to cooperate. But these interactions are dwindling and their future is uncertain; few initiatives are being taken. Leading Soviet scientists consistently express a strong wish to cooperate further, but little can be done without a formal framework for cooperation. There are cases where the lack of a bilateral agreement has been a clear impediment to space science exchanges.

"2. Soviet capabilities are increasingly rapidly in many areas of space science. Scientific and technical versatility has improved; data are more reliable; and missions can be mounted more rapidly and with greater confidence.

"3. As Soviet capabilities have increased, their space program has become more open. The expansion of Soviet cooperative activities with other countries in space further improves their capabilities, and presents the possibility that the U.S.S.R. will become a leader not only in space science but also in international cooperative ventures in space.

"4. Increased Soviet mission capabilities mean that a fundamental change has occurred in the relative balance between the U.S. and Soviet space programs. In certain scientific areas, we may now have more to gain from the Soviets than they from us. In the future, technology transfer could well become a more realistic Soviet concern, as the direction of potential transfer becomes increasingly two-way."

We share the national security and foreign policy concerns ably summarized in the OTA report. We concur that, under no circumstances, should space cooperation be carried out in a way that would harm national security. At the same time, the scientific panel's testimony has made it clear that the current sophistication of the Soviet space program offers opportunities for cooperation without risk of technology loss on our side but with considerable potential for scientific gain.

Illustrative of opportunities currently being lost are separate scientific missions to Mars in 1988 (U.S.S.R.) and 1990 (U.S.). These missions could have been coordinated, and even arranged to occur in the same year with complementary objectives, if formal channels of communication had been available. Such coordination would involve no technology transfer, yet vastly enhance the return on investment for both nations. As space missions continue to increase in cost and complexity, the advantages of carefully-managed coordination will become even more compelling.

Today we commemorate the 10th anniversary of the historic link-up of manned American and Soviet spacecraft in a dramatic demonstration of cooperation. Renewed cooperation on the scale of Apollo-Soyuz may not be feasible at this time, but the lingering memory of Apollo-Soyuz demonstrates the validity of aspirations we believe are shared by all peoples and worth pursuing. Renewed U.S.-U.S.S.R. space cooperation on a more modest but scientifically substantive scale would serve the U.S. national interest and the interests of the international scientific community. Indeed, international cooperation on the frontier of space would benefit all humankind. Therefore, we would encourage the President to discuss the possibility of resuming U.S.-Soviet space cooperation when he meets with Soviet leader Gorbachev in Geneva this November.

We thank the members of the OTA staff, especially John Andelin, Nancy Naismith and Nancy Lubin, under OTA Director John Gibbons, for their contributions to an excellent report and hope that it will receive wide readership.

Mr. NELSON. All right. Now, you mentioned the contingency studies for a minimum of space station coordination. You mentioned this in your testimony, I think on page 3. Why don't you elaborate on that space station coordination?

Mr. MATSUNAGA. Well, certainly in order to get to Mars, or to any of the planets beyond, it is absolutely essential that we have space stations. The launch pads will be not here but out in space stations. And in order to take the first step toward a mission to Mars—and I say this, I say mission to Mars, because it's something that we already have planned in both the U.S. and U.S.S.R. to get to for samples to return, photos to take, et cetera—and the launch pads would need necessarily to be, from my understanding—and I am no scientist, but you might check with other scientists.

And so, while we have the—while we need to build the space stations, why can't we not work together so that even our shuttle could say even link up with the space station Salyut, for example. And the cooperation there would be one of tremendous import. And then it would even lead to a cooperative effort for further exploration into space.

Mr. NELSON. Senator, why don't you share with us how you became so involved in this subject?

Mr. MATSUNAGA. Well, Mr. Chairman, it's a long story. Even as a child, since having been born and raised in Hawaii, there were the clear skies in Hawaii, both during the day, at night. Well, you could see the stars so clearly. And one evening I was in the back yard counting stars, and my father came out and said, what are you doing, and I said, I'm counting the stars. And he said well, son, I think you can do that better during the daytime.

And then, when I came to the House in 1962, Hawaii had already been a State for over 3 years, and I looked up at the ceiling in the House Chamber—I don't know if any of you have ever stopped a moment to do that—but I looked up at the ceiling and I counted the stars surrounding the American eagle. And low and behold, there were only 48, and Hawaii was missing and so was Alaska.

So, I went up to the Speaker of the House, John McCormack of Massachusetts, at that time, and I asked him, I said, Mr. Speaker, when are you going to put that star up there for Hawaii? And he said, as soon as you tell me, Sparky, who else but you would count the stars?

Well, I learned subsequently that the Speaker was up against two problems; one was the high cost—$2,000 just to put the stars there—and how to put two stars up there without having to respace all 48. But after 2 years of getting the same answer, I thought to myself, well, maybe he means what he says.

So, when I had Congressman Hanna and Congressman Leggett, both of California, sitting next to me in the Chamber one day, I said to them, hey you guys, will you do me a favor, will you count the stars up there? And Hanna was a joker—you probably knew him—and he said—I asked him, I said will you do me a favor, will you count the stars up there? And Hanna said, well, nothing better to do. And Leggett said, hey, there are only 48.

So, then I took them both up to the Speaker and said, Mr. Speaker, here are two other Members who have counted the stars. And

he roared, he slapped his knee, and he said OK, Sparky, you win, you win. And that's how we got a Hawaii star up there.

And when one day, after the stars were put up, I saw Congressman Ralph Rivers on the floor, he's from Alaska, and I said Ralph, did you see those two brandnew stars up there? Instead of having to respace all 48, they put one at the head of the eagle and one at the tail of the eagle. I said Ralph, do you see the two brand new stars up there? And he said—well, he didn't even know they were up there, so I said Ralph, I want you to know that I was responsible for getting the two stars up there, so I'm telling you right now that the one at the head of the eagle is for Hawaii. [Laughter.]

Well, anyway, the stars have always fascinated me. And Hawaii, because of its clear atmosphere, as you well know, today has six giant telescopes there owned by consortia, Canada, France, England, the Netherlands, the United States, of course, and Japan is now planning to build a giant telescope there.

So, in astronomy we are looked to, by the entire world, as the best spot in the world. And Hawaii, and Hawaii's citizens, are now very conscious about space. And that's one reason. And of course the other is that I've always felt that humankind needs something challenging beyond this Earth in order to realize that we are of one. And if you talk to the astronauts and the cosmonauts, and you talk to Senator Garn and Ellison Onizuka from Hawaii, and those who have been on the shuttle, that when they're up in space, they look down at the Earth, it's a beautiful planet of one. They can see no divisions on that planet Earth.

And it dawned more and more upon me that this is the way to go toward world peace. Challenge humankind so that they need to work together to conquer something beyond them. And, a common language—as I was constantly reminded when I was at the University of Hawaii studying educational psychology—that a common language is the single strongest bond of unity. And in science you have a common language. So, this is the way to go. Where you have a common language, no misunderstanding. And so, this is the way I figured would be best to promote world peace, along with my United States—of peace, which took me 21 years to get passed on the Congress and signed by the President. It's a long story, but——

Mr. NELSON. Thank you, Senator. Mr. Andrews?

Mr. ANDREWS. I want to thank you very much for coming today, Senator. I really appreciate your testimony and your personal observations. Just a few questions.

In your testimony you mentioned that the space race was a wasteful process, and I'm not sure that I either understood you correctly or I'm quoting you correctly. But I wonder if you would elaborate on that a little bit and explain to us exactly what you mean by that.

Mr. MATSUNAGA. Yes; I say it's a wasteful process in that had we cooperated among the advanced nations of the world, then we could have reduced the cost, our own cost, that is, and the cost of others. So, assuming that we were in cooperation with just the Soviet Union to get to the Moon, for example, what happens is our cost would have been reduced by half. That's what I mean.

Mr. ANDREWS. You mean an economic cost, wasteful economically?

Mr. MATSUNAGA. That's right.

Mr. ANDREWS. President Reagan has made an overture to the Soviets, an offer, to have an experimental rescue mission, of that I'm sure that you're very well aware. They've yet to respond to that. You alluded to it in your statement.

What makes you confident, or gives you hope, that they'll be anymore responsive to an overture of a joint mission to Mars?

Mr. MATSUNAGA. Well, I believe that scientists—and I've talked to a number of them—feel that without the umbrella of a political agreement between the two countries, that they cannot, they are not free to enter into any sort of exploration jointly with the American scientists.

Roald Sangdeev, for example, he's the head man of the space scientists in the U.S.S.R., he said we are not as free as the Americans. The Americans are not tied down by politics as we are. We have got to have a political umbrella, and that is the U.S.-U.S.S.R. space cooperation agreement which was permitted to expire in 1982. I was told this in 1983.

Mr. ANDREWS. This question might be better addressed to the director, but just assuming they're ahead, that they have plans for an unmanned landing on Mars in the future, not distant future, but why would they want to cooperate with us? Why would they want—if their horse is about to win the race, why do they want to wait for our horse?

Mr. MATSUNAGA. Well, I think they realize, too, that there are things that we know that they don't know, and of course we realize that they know something which we may not know. But we have the disadvantage of being an open society, and the more we begin to close up, the more we begin to become like them because they're a closed society. But the more they open up, the more they get to be like us. And hopefully we will be able to entice them to a point where that window of observation we had into their space programs, that space cooperation agreement will be returned again.

Because, as you well know, they're a secretive society and we lost that open window to their programs. And I think the renewal of that agreement will open that window again. And then, I think, by giving the benefit of the doubt to them we can continue to benefit from each others findings, experiments, et cetera.

Mr. ANDREWS. In your opinion, is landing a man on Mars equivocal to—equivalent to our landing a man on the Moon? Are they similar in terms of the way they will be perceived by the world, and would we lose, in the world's eye?

Mr. MATSUNAGA. Hopefully it will be by joint effort. And singly I doubt that the cost will even permit us to get there for a long, long time. But if we work not only with the Soviet Union, but with other nations as well—Japan, as I understand, is very much interested and so is France and England—whatever other nations are interested in getting in on it, I think it should be a joint effort. And if it's a joint effort, of course, the entire program will have the advantage of technologies known perhaps to all the nations, but unknown to any single nation.

Mr. ANDREWS. Do you think the Mars landing will be the milestone that sputnik was a milestone, and the milestone that the Moon landing was?

Mr. MATSUNAGA. I think it will be a definite milestone, yes, but before getting to Mars—if you're referring to a manned mission to Mars—it's quite a ways off yet. But even to that extent we need to take steps, which would take cooperation among nations, if we are to reduce the cost and accomplish the feat in the shortest time possible.

Mr. ANDREWS. Thank you very much, Senator.

Mr. NELSON. Thank you, Mr. Andrews. Mr. Slaughter? Mr. Smith?

Mr. SLAUGHTER. No questions.

Mr. SMITH. No questions.

Mr. NELSON. All right. Does any of the staff have any questions? Well, Senator, you have appropriately opened our series of 2 days of hearings, and we'll be sure to send you a transcript of the entire hearings. But of particular interest, as you have made reference twice now in your testimony this afternoon, the scientists that are coming who have worked on the Vega mission, that we'll send you a copy of that testimony.

Mr. MATSUNAGA. Good.

Mr. NELSON. And we appreciate you sharing your ideas with us. We appreciate your leadership. And I'm very, very ready for us to pass that resolution on the International Space Year. It's a natural, and you and Jake (Garn) and Bob (Walker) and I will get that thing moving. We thank you very, very much.

Mr. MATSUNAGA. Well, thank you very much for your leadership and for the subcommittee's leadership in this matter. And with support such as yours, I know we'll be on our way to a manned mission to Mars.

Mr. NELSON. Very fine. Thank you, Senator. While Mr. Beggs is coming up, I will share a couple of the ideas that I had that we deferred. The fact that this is the 10th anniversary of Apollo-Soyuz gives us an historical launch point from which to have these particular hearings. And yet, the deterioration of the relations of the two countries has prevented further cooperative efforts on the scale of Apollo-Soyuz.

In fact, even in 1982 the United States-Soviet space cooperation agreement was allowed to expire when the martial law was declared in Poland. And since that time, there has been some scientific interchange demonstrating that there is interest, albeit uncertain in cooperation between the two countries. However, an invitation made to the Soviets over a year ago to participate in a joint space rescue mission still remains unanswered.

Now, there are indications that both governments would welcome some reduction in the tensions that have built up over the last several years. So, I would phrase the question, could it be that space flight is the building block toward greater cooperation among all nations, and particularly these two nations, the subject of these hearings? Can we start with small symbolic gestures?

Well, on this committee we are trying to do that. We invited, with NASA's approval, the ASTP cosmonauts to view one of our shuttle launches at the Kennedy Space Center. We are also hopeful that space cooperation may become a topic of the conversation at the summit this November. This is an optimum time, then, for

these hearings to be held, and it's an optimum time for us to have more exchanges.

It is also no secret that this committee has requested of the Soviets an invitation for us to take our three American Apollo-Soyuz astronauts to the Soviet Union for a 10-year celebration of Apollo-Soyuz.

Now, these hearings are designed to investigate the record of past successes and failures, and to assess the potential gains and drawbacks of future scientific cooperation in space. Later on today we will hear from a representative of the OTA, talking about their recently released report. And tomorrow we will hear from the original American ASTP astronauts who will offer their perceptions of the successes of the Apollo-Soyuz, as well as their prediction of future cooperative endeavors. And then they will be followed tomorrow by a panel of prominent scientists who have continued to cooperate on scientific missions with the Soviets on an individual basis, scientist to scientist.

So, Mr. Beggs, you are an achieving administrator. We are delighted that you're here to speak on this topic.

And before we get into the subject of the hearing, it is most timely that I ask you the question of the present mission, if you would give us an overview summary and your impressions, we would appreciate it, and then proceed with your testimony.

Mr. BEGGS. Yes, sir, thank you, Mr. Chairman. The current mission, I'm pleased to report, is going well. We had, of course, sort of a heart-stopping event yesterday in the launch. We are planned in the shuttle program to take care of any of a number of different contingencies, and some of that planning came into play with the launch as it went forward, fortunately to a successful conclusion yesterday.

Five minutes and fifty-odd seconds into the flight, we lost shuttle main engine No. 1, which we believe to be a shutdown of the engine due to failure in the temperature sensors, not a failure of the engine. I would like to reemphasize that. It was not a failure in the basic operation of the engine. The engine appears to have been working fine, but what we had were two simultaneous failures in the temperature sensors in one of the turbo pumps on the engine, which causes an automatic shutdown of the engine.

Of course the reason we do that is that if there is any possibility that the engine would overtemp, it would go well above the operating limits of the engine, we would want to shut it down because otherwise the turbine would go out of control and throw turbine blades all over the place. And that's kind of an unhealthy situation.

So, what we appear to have—and we will not know conclusively—but what we appear to have had was a failure in two different sensors—because each of these things is redundant—and that shut the engine down. The reason that we know that is that after everything settled down after the launch, we went back and reviewed the data that we record. And the pressures in that pump were absolutely flat right up to the time that the engine shut down. Now, if it were overtemping, the pressures would have been rising. So, we are reasonably sure that what we had was a failure in the sensors that control the machine, rather than the machine itself.

While it's not a happy situation, we do have a backup sensor under development right now, having suspected that this sensor was not all that reliable. By all that reliable, it's got to operate continuously over the life of the engine without failure for literally thousands of seconds. So this one is reliable indeed, but the next one will be even more reliable. And we are in the qualification phase of qualifying the next sensor.

After the engine No. 1 cutoff, at 5 minutes and 53 seconds into the flight, we quickly made a check on the two remaining engines and found that they were operating nominally, and made the decision to go on into orbit.

There is a term of art that we use, which is unfortunate, and which has been reported on the press in an unfortunate way, in that we describe that as aborting to orbit. In actual fact we are going normally into orbit. But we use that term to describe an entry into orbit with less than the three operational engines.

We had two engines we throttled up to 104 percent, which is well within the capability of the engines, and we ended up just about 110 or 120 feet per second short in velocity from what we had planned to do. That's 110 or 120 feet per second out of 15,000-plus feet per second velocity that we have to achieve in order to go into Earth orbit.

So, we're just a little low—a tad low—and we do have sufficient fuel on the orbiter in the orbital maneuvering system to adjust that orbit during the course of this mission, and we will do that. At the same time, the scientists would like to do a good deal of maneuvering which we had planned to do, so we will program the mission so as to give the scientists the maximum return from the mission. The scientists, I should add, are very happy with the mission. Presently, we have a little bit of a problem with the Instrument Pointing System; this is the first time we have flown the IPS, the Instrument Pointing System, which, I should acknowledge, is another gift from our friends at ESA, the European Space Agency. So, it's the first flight of that equipment. It is a very accurate pointing system. And as you would expect, on the first flight, we're having a little trouble tweeking it up to its maximum operational capability. But I feel confident that we will get everything we need.

The only experiment on the flight which is in any jeopardy is an English experiment—1 out of 14 experiments—which was intended to observe the helium percentage in the Sun's chronograph, the Sun's corona. We may be a little bit short of achieving full results on that, although we will get some results for sure, and maybe full results on that. So, we're very pleased.

The astronauts are doing well. We have been working in two shifts because this is a Spacelab mission that requires round-the-clock operations, so they are working in two shifts and are doing a lot of work; a lot of science is being accomplished. And we hope that we'll have some very good results and very good films to show when they come back.

Mr. NELSON. I have heard that you will be able to get about 90 percent of your science experiments completed.

Mr. BEGGS. I think a little better than 90 percent, Mr. Chairman. It's only the one out of—there are 14 discrete experiments on this flight, and it's only one that we're concerned about at the present

time. So, it will be something over 90 percent, assuming, of course, that all goes well from here during this 7-day mission.

Mr. NELSON. And, of course, the experiments that depend microgravity, such as the protein crystal growth, that, of course, goes nominally——

Mr. BEGGS. Sure.

Mr. NELSON [continuing]. Because you're in the microgravity environment.

Mr. BEGGS. Indeed.

Mr. NELSON. OK. Are there any questions from the committee? All right, please, if you'd proceed with your testimony.

STATEMENT OF JAMES M. BEGGS, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. BEGGS. Thank you, Mr. Chairman and Members of the subcommittee. It's a pleasure to be here today to testify on the United States-Soviet space cooperation from NASA's perspective.

U.S.-U.S.S.R. cooperation in space research goes back to the first planning of space projects in 1955 for the International Geophysical Year, IGY, and that was even before NASA was formed. Cooperative efforts with the Soviet Union continued and expanded during the 1960's and the 1970's. At the 1972 summit meeting in Moscow, President Nixon and Soviet Premier Kosygin signed an agreement on Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes. The governmental agreement called on the two countries to carry out a broad range of joint efforts in space science and applications, and to embark on their first major joint development effort, the Apollo-Soyuz test project, the ASTP.

During the 1970's and early 1980's, many productive efforts were undertaken by U.S.-U.S.S.R.; joint working groups established in space biology and medicine, lunar and planetary research, remote sensing and meteorology. In the multilateral area, the United States and the Soviet Union, in cooperation with Canada and France, have participated since 1979 in a highly successful satellite aided search and rescue project, known as Cospas-Sarsat. This humanitarian program has been directly responsible for saving 475 lives to date, vividly demonstrating the tangible benefits of international space cooperation.

If I can expand that just a little bit, Mr. Chairman, because I think it's important to your hearings here today. We now have the full constellation in orbit. They have three transponders on three satellites, we have two satellites. Our two satellites are roughly equivalent to the three that they have operating. So, the full constellation is operational for anyone traveling any place on the Earth now, who carries around this little few hundred dollar transponder. We can locate them in most places on the Earth within an hour, and in other places a little more remote on the Earth within a couple of hours. So, we are very well instrumented to save a lot of lives, because the last time we checked on this, something in the order of 3,000 or 4,000 people have been disappearing on the face of the Earth every year without a trace. So, it's working very, very, well.

Of course, the political relationship between the United States and the Soviet Union will remain the most important factor determining the level and scope of cooperative space activities between our two nations. A key reason why U.S.-U.S.S.R. space cooperation has not always yielded its full potential has been aggressive Soviet behavior which has undermined the political basis so necessary for fruitful partnership. During the past decade there have been a number of Soviet political and military actions which have directly and adversely affected progress in U.S.-U.S.S.R. space cooperation.

The United States-Soviet bilateral relationship in the space area began to languish in the 1970's, late in the 1970's, as a result of a progressive deterioration in the overall political relationship with Moscow. Following the imposition of martial law in Poland, as has been noted here, the Government level space agreement was allowed to lapse in 1982 as an expression of U.S. disapproval.

NASA and its Soviet counterparts have, however, continued to work together on programs of a multilateral character, or programs which represent rather straightforward extensions of previously initiated activities. In June, in cooperation with the French, NASA's deep space network tracked the two Soviet Vega spacecraft during their encounters—that's with Venus.

Three weeks ago, Cosmos 1667, the latest Soviet biosatellite mission, was launched and carried a United States primate cardiovascular experiment on board. In addition, just 2 weeks ago, NASA officials participated with their Soviet, Canadian, and French partners in a Cospas-Sarsat steering committee meeting in Seattle.

It is clear that there have been significant scientific benefits to the United States over the years from undertaking carefully constructed cooperative space projects with the Soviet Union. Throughout, the United States has sought to identify science, applications, and development projects which contribute to United States space objectives and utilize complementary Soviet space capabilities without incurring United States technology loss. I believe that the record shows that this can be done successfully.

There appear to be mutually beneficial opportunities for cooperation with the Soviets during the 1980's and 1990's, and we understand the desire of United States scientists to see them come to fruition. It would be particularly worthwhile to coordinate our plans and scientific operations in planetary studies and life sciences. Other fields of space science cooperation, such as astronomy, astrophysics, and Earth sciences, could have equal promise.

Given the right political setting, one could imagine even grander collaborative possibilities; as was discussed during the recent Planetary Society/AIAA meeting on missions to Mars. We share interests in the unmanned and manned exploration of that planet, as well as in establishing a permanent human presence on the Moon.

As in the past, future projects should be scientifically justified, technically feasible, conducive to safeguards against technology transfer, and, where applicable, have cost benefit ratios at least comparable to alternative projects on which resources could be spent.

Due to their high visibility and long leadtime requirements, projects involving major cooperative hardware development entail genuine risks of disruption due to changing political conditions

over the long term. Such proposals should be considered very carefully by both sides before making a commitment to undertake them.

Last year President Reagan publicly stated his desire to increase contacts with the Soviet Union, and his willingness to work with the Soviets in cooperative space activities which are mutually beneficial and productive. In that spirit he has proposed that a joint simulated space rescue mission be undertaken using the shuttle and the Salyut spacecraft, in which astronauts and cosmonauts would develop procedures for use in space emergencies.

Although the Soviet response up to now has not been positive, if they were to accept, we could probably work it into our shuttle schedule relatively rapidly. We would like to do it, and it would demonstrate our capabilities to work peacefully together in space for humanitarian purposes. The United States proposal remains on the table, and we hope the Soviets will reconsider their position in the future.

To sum up, we are interested in rebuilding our cooperative activities with our Soviet counterparts, and want to broaden their scope to incorporate new ventures that are mutually beneficial and productive. It is our hope that our Soviet counterparts will share this interest.

Thank you, Mr. Chairman. I'd be pleased to respond to questions.

[The prepared statement of Mr. Beggs follows:]

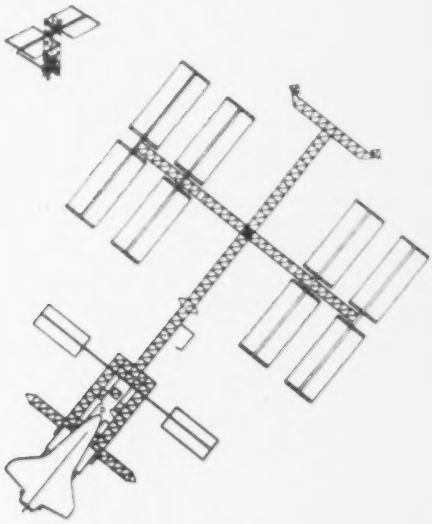
NASA
National Aeronautics and Space Administration

Hold for Release Until
Presented by Witness
July 31, 1985

Subcommittee on Space Science and Applications
Committee on Science and Technology

House of Representatives

Statement by:
James M. Beggs
Administrator



99th Congress

HOLD FOR RELEASE UNTIL
PRESENTED BY WITNESS

JULY 31, 1985

Statement of

James M. Beggs
Administrator

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Space Science and Applications
United States House of Representatives

Mr. Chairman and Members of the Subcommittee:

It is a pleasure to be here today to testify on United States-Soviet space cooperation from NASA's perspective.

I need scarcely remind this audience that international cooperation in space has been a fundamental principle of the United States' space program since its inception. The National Aeronautics and Space Act which created NASA in 1958 directed the Agency to cooperate with other nations in peaceful space activities and to share the benefits of space research on a worldwide scale. This policy has been reaffirmed by every Administration and Congress since, and particularly by President Reagan.

U.S.-U.S.S.R. cooperation in space research goes back to the first planning of space projects in 1955 for the International Geophysical Year, even before NASA was formed. In a series of international meetings at that time, American and Soviet scientists and those of other nations sought to develop conventions for a wide exchange of data. During the 1960's, President Kennedy and Soviet Premier Khrushchev began a dialogue which ultimately led to joint projects in telecommunications and geomagnetic mapping and in addition, established the "cold line" communications link in 1962 for 24-hour exchange of meteorological data between Washington and Moscow. These efforts demonstrated that our two countries could work together productively in mutually beneficial areas of space research.

Cooperative efforts with the Soviet Union continued and expanded during the 1970's. At the 1972 summit meeting in Moscow, President Nixon and Soviet Premier Kosygin signed an agreement on "Cooperation in the Exploration and use of Outer Space for Peaceful Purposes". The governmental agreement called on the two countries to carry out a broad range of joint efforts in space science and applications, and to embark on their first major joint development effort--the Apollo-Soyuz Test Project (ASTP). The primary objective of ASTP was

to demonstrate the technical feasibility of a compatible docking system that would facilitate future cooperation in manned spaceflight between the United States and Soviet Union. Ten years ago this month—in July 1975—the U.S. Apollo and Soviet Soyuz spacecraft docked successfully for two days, during which time crews were exchanged and joint experiments were conducted.

During the 1970's and early 1980's, many productive efforts were undertaken by U.S.-U.S.S.R. Joint Working Groups established in space biology and medicine, lunar and planetary research, remote sensing and meteorology. In the planetary area, lunar samples were exchanged in 1976, Venus studies were conducted and landing sites were jointly selected for Soviet Venus lander missions. In space biology, detailed exchanges of biomedical data from manned missions occurred regularly and continue at present. U.S. scientists also flew plant and animal experiments on several Soviet biosatellite missions. In the multilateral area, the United States and the Soviet Union, in cooperation with Canada and France, have participated since 1979 in a highly successful satellite-aided search and rescue project known as COSPAS-SARSAT. This humanitarian program has been directly responsible for saving over 410 lives to date, vividly demonstrating the tangible benefits of international space cooperation.

The U.S.-Soviet bilateral relationship in the space area began to languish late in the 1970's, as a result of a progressive deterioration in the overall political relationship with Moscow. Work on the proposed Shuttle-Salyut project, the follow-on to Apollo-Soyuz, slowed sharply and was eventually suspended. High-level joint space meetings were deferred and no new initiatives for major scientific cooperation were proposed. Following the imposition of martial law in Poland, the Government-level space agreement was allowed to lapse in 1982 as an expression of U.S. disapproval.

NASA and its Soviet counterparts have continued to work together on programs of a multilateral character or programs which represent rather straightforward extensions of previously-initiated activities. In June, in cooperation with the French, NASA's Deep Space Network tracked the two Soviet VEGA spacecraft during their encounters at Venus, and measured the position and speed of French-built balloons released intothe Venusian atmosphere. Three weeks ago, Cosmos 1667, the latest Soviet biosatellite mission, was launched and carried a U.S. primate cardiovascular experiment onboard. In addition, just two weeks ago, NASA officials participated with their Soviet, Canadian and French partners in the first COSPAS/SARSAT Steering Committee meeting in Seattle, to continue joint planning for the current initial operational phase and the post-1990 fully-operational period of the program.

It is clear that there have been significant scientific benefits to the United States over the years from undertaking carefully-constructed cooperative space projects with the Soviet Union. Throughout, the United States has sought to identify science, applications and development projects which contribute to U.S. space objectives and utilize complementary Soviet space

capabilities without incurring U.S. technology loss. I believe the record shows this can be done successfully.

There appear to be mutually beneficial opportunities for cooperation with the Soviets during the 1980's and 1990's, and we understand the desire of U.S. scientists to see them come to fruition. It would be particularly worthwhile to coordinate our plans and scientific operations in planetary studies and life sciences. There are broad parallels in our solar system exploration efforts and in our interest in the physiology of long-term human presence in space. We could exchange data, cooperate in analytical efforts making use of each side's special expertise, and conceivably fly instruments on each other's missions. Other fields of space science cooperation, such as astronomy, astrophysics and earth sciences could have equal promise. Given the right political setting, one can imagine even grander collaborative possibilities; as was discussed during the recent Plantetary Society/AIAA meeting on missions to Mars, we share interests in the unmanned and manned exploration of that planet, as well as in establishing a permanent human presence on the Moon.

As in the past, future projects should be scientifically justified, technically feasible, conducive to safeguardsagainst technology transfer, and, where applicable, have cost-benefit ratios at least comparable to alternative projects on which resources could be spent. Due to their high visibility and long lead-time requirements, projects involving major cooperative hardware development entail genuine risks of disruption due to changing political conditions over the long term. Such proposals should be considered very carefully by both sides before making a commitment to undertake them.

Of course, the political relationship between the United States and the Soviet Union will remain the most important factor determining the level and scope of cooperative space activities between our two nations. A key reason why U.S.-U.S.S.R. space cooperation has not always yielded its full potential has been aggressive Soviet behavior which has undermined the political basis so necessary for fruitful partnership. During the past decade, there have been a number of Soviet political and military actions which have directly and adversely affected progress in U.S.-U.S.S.R. space cooperation.

Last year, President Reagan publicly stated his desire to increase contacts with the Soviet Union and his willingness to work with the Soviets in cooperative space activities which are mutually beneficial and productive. In that spirit, he has proposed that a joint simulated space rescue mission be undertaken using the Shuttle and the Salyut spacecraft, in which astronauts and cosmonauts would develop procedures for use in space emergencies. Although the Soviet response up to now has not been positive, if they were to accept, we could probably work it into our Shuttle schedule relatively rapidly. We would like to do it, and it would demonstrate our capabilities to work peacefully together in space for humanitarian purposes. The U.S. proposal remains on the table, and we hope the Soviets will reconsider their position in the future.

To sum up, we are interested in rebuilding our cooperative activities with our Soviet counterparts and want to broaden their scope to incorporate new ventures that are mutually beneficial and productive. It is our hope that our Soviet counterparts will share this interest.

Thank you for the opportunity to testify before this Subcommittee today.

Mr. NELSON. Thank you, Mr. Beggs. Did the Soviets actually give us a response?

Mr. BEGGS. Yes, I believe. And I understand that the State Department will be up here tomorrow, and you should ask them the same question. And I'm not too familiar, but I believe they said that the discussion of such a mission was not timely. They didn't reject it out of hand.

Mr. NELSON. Do you think, is it your personal opinion, that space cooperation with the Soviets contributes to an improvement in the overall political environment between the two countries?

Mr. BEGGS. Well, that's a difficult question to answer. The scientists would like to believe so. And if I can speculate—and this doesn't represent anything but my personal opinion, Mr. Chairman—I think the Soviets have a serious problem. They have educated a number of young scientists superbly. Some of their young people are world class scientists, they are doing very good work. Scientists, like all human beings of high achievement, like to be recognized. And I think that these young Soviet scientists want recognition and acknowledgement that what they are doing is very good research.

I think, therefore, we have an opportunity here, because if the Soviet Union is to give those young people the opportunity to achieve that recognition, they've got to open up a little bit. And in opening up a little bit, they have got to give us the opportunity—us and the Europeans and the Japanese and the other folks who are doing first-class science—they've got to open up enough so that their people can report on their work and file the papers that are necessary to be filed in order to allow scientific recognition.

I think, therefore, that there is a political opportunity. Whether the Soviet hierarchy, the political powers that be, will allow that to develop beyond any significant point is a question or which I don't think I care to speculate. But I think that the opportunity is there. If the right climate were to develop, then I think our cooperation could be beneficial very significantly, both in a scientific way—which may be even more important than the political arena. Because if it benefits us in a scientific way, then surely in the long term, the political powers will begin to recognize that as being important. And in making that recognition, then I think the political climate could improve. But that's only my personal speculation.

Mr. NELSON. You have the advantage of being a present administrator looking back 10 years ago. We basically built the docking module and perhaps the estimate of the total cost to us, including the docking module, was somewhere in the range of $250 million for ASTP.

What is your opinion, looking back as to that expenditure, did the U.S. gain as much as it contributed?

Mr. BEGGS. Yes, I think we did. I think while it was a significant expenditure for the time, it was relatively inexpensive in that we did have a lot of hardware that we had bought and paid for left over, which could be modified to do that job with the Soviet spacecraft.

What we gained was an insight into what they were doing. We are an open society, it's very easy for them to see what we are doing, it's very easy for them to get our reports. I understand that

they subscribe to services which give them every patent that we file within a matter of a few days. And since we do most things in the open, it's much easier for them to understand what we are doing, and to draw on the experience that we have, than it is for us to draw on the experience that they have. And they do quite significant things in space. They fly much more frequently than we do, they have a very active science program, and of course they have a very active military program that is even more active than anything else that they do.

To gain an insight into that, as to the way they operate and the way that they do their job, is a very, very valuable thing, and I think we achieved that. Now, you might follow that up by asking, you know, what about since then, and the answer to that is well, we haven't cooperated except on the periphery since then. I mentioned some of the things that we still do together, but we haven't cooperated significantly so we do not have a very good insight as we did 10 years ago in how their operations go.

Mr. NELSON. All right, let me ask you about that cooperation on the periphery. The fact that we don't have a formal agreement—the space cooperation agreement lapsed in 1982—and yet we are going to have two of our scientists come and testify tomorrow as to how they were working on this Vega spacecraft, the Russian spacecraft.

So my question to you is, in the absence of a formal agreement, how is NASA able to formalize these arrangements?

Mr. BEGGS. Well, we do it just that way. We do it through private institutions who can, of course, cooperate on their own. That is, at the same time, good and bad. It's good in that we can continue to exchange with them, and we get some opportunities to fly that we might not otherwise get. That package that Dr. John Simpson, that flew on the Vega mission to the Halley's Comet, is a very valuable instrument and it's a very important thing for us. That's the good part of it. The bad part of it is that as a consequence of the lack of a formal agreement, all of these arrangements have to be worked out outside of the sort more direct and formal arrangements the governments have together, and so it's more difficult to do. Not only is it more difficult to do, it gives them an opportunity to play our system in a way that a closed system can play an open system. That is, they can go and talk to the private institutions and get them to do things for them, for which we get no quid pro quo. And as a consequence, the absence of a formal agreement I think is a substantial disadvantage.

Mr. NELSON. So it just makes it tough for you dealing through third parties. It would be so much easier if you could deal agency to agency, but it would be an awful lot easier if you had the stamp of approval of government to government.

Mr. BEGGS. Yes.

Mr. NELSON. That's a fair summary.

Mr. BEGGS. It's a little more difficult to arrange, but it does work obviously because we are continuing to work with them.

Mr. NELSON. That's very interesting. Mr. Andrews?

Mr. ANDREWS. Well, just a couple of questions. I really applaud your vision and your leadership on this particular issue, and share

your hope that a joint effort will encourage and facilitate better relations with the Soviet Union.

Mr. NELSON. However, just in looking back as to the mid-1970's and our joint effort then, would you not agree that in terms of concrete relations in space, we really didn't see any productive efforts on the part of the Soviet Union to lessen tensions, to lessen the militarialization of space—on the contrary. I'm just curious what your view would be, what your observations——

Mr. BEGGS. Well, I don't think you can expect—I regret—that I don't think you can expect any short-term improvement from scientific cooperation. Necessarily the kind of thing we have done—you know, we've been cooperating scientifically, and other ways, with the Europeans for maybe five or six or seven generations. And yet, we continue to have some problems with our European friends, even though I think I would argue that our relationship with the Europeans is perhaps the most cordial and effective relationship that has ever existed in the world.

Certainly much of that relationship is due to the fact that we exchange intellectually. Our scientific work causes us to know each other at the highest levels of academic activity. And that's got to be important, but you can't develop it over night, it takes a long time to develop it.

And I think the fact that we had unfortunately too brief an exchange with the Soviets, which did cause us to know a lot of their people a lot better than we knew them before—as a matter of fact, the academician who is currently working this area, Dr. Sagdeev got to know a lot of us through that exchange, and we know him very well.

Now, again, that's both good and bad. He can now come over here in the absence of an agreement and wander around and talk to many of his old friends, which he does. He was here earlier this year, and he just travels from place to place and chats with the people he's gotten to know over the years. And they talk about future cooperation. And as I say, it's outside the formal arrangement of an agreement, and so it's disadvantageous to us.

But those personal relationships cannot help but improve things over time. But you can't expect them to improve them very quickly. It's going to take time to know a lot of them and understand a lot of them. But I— you know, one of the things that's put a lot of pressure on the Soviets in the last several years is the fact that many Western scientists knew personally Mr. Sakharov. And when Mr. Sakharov got in trouble with his own government, there was a great hue and cry in the international community. And the consequence of that is that the Soviets have been embarrassed, and I think have suffered a good deal of maybe psychological damage to their image. And I think that hasn't helped Mr. Sakharov, I'll have to admit, but I think it's probably in the future going to help some of their other intellectual communities to maintain a position in their own country that's maybe a little bit out of—just a little bit out of kilter with the official position of their government. And I would suggest that all that's good.

Mr. ANDREWS. If we don't reach an agreement with the Soviets, will we find ourselves, as a nation, in a space race to see who can put the first man on Mars?

Mr. BEGGS. Oh, golly, you're talking about something that is so long term that it's hard to speculate on. I've given a couple of speeches on this, and I believe that if we're going to go to Mars, if any nation wanted to do it, they would want to collaborate with the other major space faring nations.

A mission to Mars is an immensely complex thing. Just getting there is a 200 plus day voyage, so the total mission is a year and a half long or so. And you would have to develop a lot of technology and do a lot of things in R&D. I really don't think we'll undertake that mission until well into the 21st century. But it's a fascinating mission, and it's one of those that we continue to study as something that would be desirable in the future.

Whether they would undertake—of course any advanced nation, if they're willing to expend the resources, probably could do it alone. We could do it alone and they could do it alone. But I think the compelling resource problem would cause you to want to collaborate. And I think since it involves no particular military aspects to it, I think it's one of those things that you would reach out to try to get somebody to share the burden with you when you sat down and thought about it.

Now, an unmanned mission to Mars, of course we've put landers on Mars. We've explored Mars extensively, the Soviets not so much. They've been concentrating on Venus. But unmanned probes to Mars, they could probably do that whenever they want to. They apparently have such a mission in planning, to which they've invited the Europeans and us. Unfortunately we could not respond at the time they asked us whether we'd be interested, but that they can do. They can certainly do that.

Mr. ANDREWS. In such a mission, are you confident that we can protect our technology?

Mr. BEGGS. I am confident that we can set up a system that would make it just as difficult for them to acquire the technology we want to protect, as it is today for them to acquire any technology. But I have to acknowledge, you know, they've been exceedingly successful at penetrating our institutions and acquiring technology. And that risk always exists, but that exists whether we cooperate or not. But I'm confident that we can set up systems just as we did back in the ASTP days to protect those things we don't want them to have access to.

You've got to define the interfaces carefully, and then you've got to ensure—you've got to set up control systems so that the technology or the information that moves back and forth is very carefully monitored so that you don't give them anything you don't want to give them.

Mr. ANDREWS. What's your best guess, would they be interested? Will they say yes to our overture?

Mr. BEGGS. Well, they say they are interested. Dr. Sagdeev, as I mentioned earlier, was over here earlier this year and he said that they are very interested. Several of their other academicians have been talking to our people, and they say we're very interested in this kind of collaboration.

Since the Soviet Academy is an arm of the government, unlike our academies which are more or less independently governed, they are very closely integrated into the government. I've got to

assume that they are representing a policy view of their government. And they say they're interested in collaboration.

Mr. NELSON. Would the gentleman yield?

Mr. ANDREWS. Surely.

Mr. NELSON. You're talking about collaboration on a joint manned Mars mission?

Mr. BEGGS. Oh, no. I'm talking about collaboration on unmanned missions and other science.

Mr. NELSON. Well, you were referring to the manned——

Mr. ANDREWS. I was talking about the manned mission to Mars.

Mr. BEGGS. I'm sorry, I misunderstood you, Mr. Andrews. We haven't heard from them on the subject of a manned mission. If they have such a mission in planning, which by active planning I mean something that would take place let's say in the next 10 or 20 years, we haven't heard about it.

Now, everyone—the United States, the Soviet Union, and even the Europeans—have been scratching on paper about the idea eventually of a manned Mars mission. But again, I think what you're talking about is something that maybe 30 or 40 or more years out, because it would be an immense undertaking.

Mr. NELSON. Would the gentleman yield further?

Mr. ANDREWS. Surely. I'll pass the witness at this time.

Mr. NELSON. Well, I just want to follow. There has been no policy decision in our Government that we want a joint mission manned to Mars.

Mr. BEGGS. No, sir.

Mr. NELSON. Now——

Mr. BEGGS. We would respond if we were approached, I guess, on an ad hoc basis. We have not been asked, and we have not been considering such a mission ourselves anytime in the near future. Again, by the near future I think I would say the next 20 years, which is about as far ahead as we look on an active project.

Mr. NELSON. Was that a glimmer of hope for the future when the decision was made to offer the cooperative rescue space venture?

Mr. BEGGS. Well, you've heard me on this subject a number of times, Mr. Chairman. The near Earth orbit activities that we're proposing to pursue for the next 10 years are precursors to further major missions, such as Moon bases, visits to asteroids, visits to Mars, and what have you, because if you want to go to Mars, the first thing that you would have to do is have a near Earth orbit, low Earth orbit base.

The reason for that is obvious. You don't have to withstand the shock of launch and the enormous energy that would be required to launch such a mission. You could assemble it in space, build the spacecraft, design and build the spacecraft to exactly the environment of Mars or the Moon, and launch and retrieve the mission at the orbital station, and then return the astronauts to Earth. That saves you a lot.

So what we're setting about doing, and what they are setting about doing, is to gain those technologies which would allow them to operate from low Earth orbit. They have been flying the Salyut spacecraft for about 14 years, if my memory serves, and they've been flying about half the time during that period. Now, we've been flying for the last 3 years in the shuttle intensively, and we're

learning a lot. I can tell you, we got a lot of experience in 20 seconds yesterday.

Mr. NELSON. I'm sure you did.

Mr. BEGGS. And the consequence of that is that the lessons we learned and the lessons they will learn can be exchanged very profitably to increase the capability of both of us to operate on long duration missions into space.

Mr. ANDREWS. One last question.

Mr. NELSON. Sure.

Mr. ANDREWS. In your opinion, why have they failed to respond to President Reagan's overture?

Mr. BEGGS. I think the answer I gave earlier is probably an honest answer, that it's not timely. I think they're not ready to do that. I think that they would prefer to wait until either they have their own shuttle operational, or perhaps have the system operational a little more completely before they enter into an exchange.

It may also be that there are political motives behind that, that they would prefer to hold such a discussion until other matters, other political issues, can be discussed. We all recall the fact that the earlier discussions between Mr. Gromyko and Mr. Kissinger, one of the things that led to that move to détente in the Nixon administration was a joint mission, which turned out eventually to be the ASTP. And they may have in mind bringing that up as an introductory issue this time. Again, I'm only speculating.

Mr. ANDREWS. Thank you, Mr. Chairman.

Mr. NELSON. Mr. Slaughter?

Mr. SLAUGHTER. No questions.

Mr. NELSON. Mr. Smith?

Mr. SMITH. Mr. Beggs, these proposed joint ventures, future ventures with the Soviet Union, aren't they more political than they are scientific? Are we grasping for something here hoping that we can pull together, I suppose, as the previous witness stated so eloquently? Is this really the motive, is it more—just to throw another point out before you respond—it just seems to me that I guess I'm at a loss as to how much we can gain from them scientifically, how much they're willing to let us have? And then I'm not sure just how much they can gain from us in the sense that—as somebody already stated earlier—they have a lot of that information anyway. And the question is, how much?

But I'm very concerned about the technology transfer. And it seems to me that if we're going to be—we have been, I think, coming down pretty hard on various corporations in this area in terms of our policy, and then if we turn around and provide it to them, as a policy of the Government, that seems to be inconsistent.

I realize there's several points there, but I just wanted to get them out for your response.

Mr. BEGGS. Well, I think any joint effort with the Soviets has to encompass the politics out of the thing. And one has to—one would have to conclude that at this time, in the kind of political environment that we live in with them across the board—and I stated some of those things in my statement—that there would be a lot of politics involved in the joint mission, and there was in the case of the ASTP.

You asked further, are there benefits that could accrue to the United States? I think the answer clearly is yes in two respects. One is that if we were able to put together some ambitious kinds of missions for the future—and they have to start, of course slowly, one has to start with something that one can do in the near term—but if you could move from that to more ambitious missions in the future, we could do a lot more comprehensive and ambitious things by sharing the burden of the more ambitious missions.

They are the other major space faring power. They are very active, and they are becoming very competent in a number of areas. For example, they launch each year over 100 times. I think it's in the order of 120 times. That gives you a lot of experience in launching. The more you launch, the better you get at it. We launched 20 odd times a year, including all our shuttle launches. In fact, it's probably down below 20 right now.

I mentioned earlier that some of their young scientists are world class scientists, and their old scientists are world class scientists. Mr. Sakharov is a Nobel prize winning scientist. They are doing some very good work. Some of their young scientists, and we meet them internationally, are superbly trained and are doing very good work. In the nuclear area, the subatomic physics, they are probably doing some of the best work in the world. In some of the areas in mathematics they're doing some of the best work in the world.

Clearly an exchange with our people with that class of individual can only help and improve our capabilities. Now, you might further ask, will they let us do that? Well, the answer to that is if you get intimately involved in a joint program with us, they probably cannot prevent us from exchanging ideas, concepts, with their more competent and capable people.

So, I think there are advantages to this country. Obviously if you're going to enter into an agreement with an enemy—and I consider them an enemy, I've spent most of my working life trying to help defend this country from them—if you're going to enter into an agreement with a potential or even an existing enemy, you do it very carefully. And any such agreement that we wrote with them would have to be drawn very carefully, and the control system that you set up to control the exchange between us would have to be done in a very careful and thoughtful way, so as to prevent the leaking out of things you didn't want them to have access to.

Mr. SMITH. Well, to follow up on a point that Mr. Andrews made, you feel that that can be done. You feel that we can have those assurances that the technology transfer is not going to occur. And given the interagency problems that you're going to have here—you know, the State Department, the Defense Department, yourselves—can these all—I know we've had one example with Apollo-Soyuz, but, I mean, this is a little more——

Mr. BEGGS. Well, the one example that's cited on Apollo-Soyuz was an acknowledged exchange. When we entered into the Apollo-Soyuz we agreed, we the United States, agreed to do the rendezvous and docking adapter. That was the job we had to do because they didn't have that technology. If we were going to do the project at all we had to do it, because they didn't have that technology. So we agreed to do that, and we taught them how to rendezvous and dock. There's no question about that.

Now, what did we get in exchange? In exchange we got access to their whole system. It was like pulling teeth. And I'm sure you all will talk to Tom Stafford, and Tom can tell you that it was very difficult. You had to kick at the door at every turn because the doors were closed. But Tom is a guy who keeps kicking, and gradually the door opened. And after a while we got in and we got a full understanding of the way they operated. And that was the only way that we could get a full understanding of how they operated, and that was very important to us.

Mr. SMITH. Maybe that's why they haven't been back.

Mr. BEGGS. And has been very valuable to us. It could be. But I think it's worth trying again. Again, I leave it up to the State Department to decide the timing and the way in which one would put together an agreement to do that. The previous agreement we had, the one that expired in 1982, I think was a good framework for operating. You may want to tweek it a little bit if you go back and do it again, but that kind of thing I think provides the ground work that one needs in order to provide an effective control on the exchange.

Mr. SMITH. One final point. Can we assure a company, a corporation, who might be involved in some other type of technology, that we would not want to get into the hands of the Soviets, when we regulate that—and I support regulating that—can we assure these companies that this kind of thing is not occurring at the hands of our Government—I mean, can we give them those——

Mr. BEGGS. I think we can protect intellectual property rights. We do that all the time. We do protect intellectual property rights. We're going to have a similar problem as we start to put together our management and technical control system on the space station, where we plan to have a close integration with both the Europeans and the Japanese, and we're paying a lot of attention to that. They worry about protecting their intellectual property rights as well, that is, the Europeans and the Japanese, and I'm sure the Russians, too, would worry about that. So, one would have to set up an effective mechanism to protect the copyright patents and other intellectual property that one has and necessarily one has to use in performing his part of the deal. But I think that can be done.

Golly, in the last—look, I'm a businessman. I've been wandering around the world doing business for the last 30 years. We enter into agreements as businessmen with foreign businessmen all the time. And one of the first things that comes on the table is what's mine is mine and what's yours is yours, now we're going to draw this interface very carefully. You do everything over here and we'll do everything over here, and we don't want you coming to this side of the interface and we promise not to come to your side of the interface. And the consequence of that is that we have, for the last—since World War II, we have organized immense international business arrangements which are highly technical in content, and I think both parties have been satisfied. More directly, if we were to do this and involve American industry, I would want the American industry to be right up front, because they know how to protect their property, and do very well when they are allowed to get in there and negotiate with their counterparts.

Mr. SMITH. One specific—go ahead, Bob, I forgot you—I'll yield. I know you want to ask questions, go ahead. We're running out of time, I'll yield to you.

Mr. NELSON. Mr. Walker.

Mr. WALKER. Just a couple of questions to follow up on a question that Mr. Smith has asked. Having learned everything that there was to know about their system in ASTP, how did that benefit our program? I mean, what did that learning do that ended up changing or benefiting our program directly?

Mr. BEGGS. Well, I think in the first instance, Mr. Walker, in learning that we changed a few of our own procedures, we improved a few of our own procedures. Not a whole lot, but we did learn something from them in operations. In the second instance, though, from a point of view of an insight into their program, we got an insight on what they would likely do in the future. That's intelligence and it's valuable.

Mr. WALKER. Well, that helps us in a military sense, but I'm wondering——

Mr. BEGGS. Well, it helps us across the board. If you have an adversary in the world that's useful to have an insight into where he is heading.

Mr. WALKER. Sure. I have an article here from this week's Business Week, that indicates that the Soviets are now going to go into competition with us in launching of communications satellites, and it's going to be a very stiff competition with them undercutting not only shuttle price, but the Arianne price as well.

If, in fact, they are going to use their space technology to be in commercial competition with us, what do you see that as doing to our ability to cooperate on joint ventures? Does that undercut it, does it enhance it?

Mr. BEGGS. Well, I don't know that I can answer the question fully. We've seen them in the marketplace, they are coming in. Now, they have come in at various stages throughout the space age. They've stood by at a launch—in fact, they've launched payloads into space for a number of foreign governments over the last 26 years. So, they've done that from time to time.

We have not seem them in the commercial marketplace for several years. And so, the first time that they have shown up is in the recent competition for INMARSAT where they lost, and they bid a very favorable price in that competition. But they lost. I think if they—they have some disabilities in competing in an open marketplace. In the first place, they don't like to open up as wide as is necessary in order to get the customer comfortable with the service they're offering. And even though they offer a very low price, you don't necessarily want to take the lowest price if you're not sure you're going to get everything that you need to get your satellites successfully into orbit. So, they have some disabilities on that line.

Now, the INMARSAT was the first time that they have indicated in writing that they would be more open. Previous to this—this is not totally fair, but it's about the way they've approached this—they'd say you deliver your satellite at the border and we will see that it gets into a proper orbit. Well, nobody wants to do that when you're dealing with a $60- to $100-million piece of hardware.

This time they said you can come on in and work with the design bureaus and follow it right on down the launch pad. To date, nobody quite believes that, and it's going to take a while before they convince the customers that they're willing to truly allow them to integrate their payloads onto the Soviet launch vehicles.

So, I don't think we should overly concern ourselves, but I think we ought to keep watching them because they could be formidable. As you know, they have no—they don't price to cost and they have no complusion in cutting the price as low as is necessary in order to get the business.

Mr. WALKER. Let me extrapolate a point, and then we've got to go and vote. But it seems to me, and I hear you say—and I don't think you've said this directly, but I gather a connotation that, in fact, you could have a joint venture that would show the world that they are more open and would open up some of their technology to the Western World. That, in fact, could make them a more potent force in the commercial market.

Mr. BEGGS. I personally think that would be the best thing that could happen in the world, is that the Soviets would open their economy and go out and try to compete. That would change their society faster than anything I can think of. They'd really get into the marketplace and try to compete——

Mr. WALKER. I think that's true, but——

Mr. BEGGS [continuing]. In a free enterprise kind of way.

Mr. WALKER. I think that's true if it went that far. But what if it only went so far as to convince a lot of commercial customers that——

Mr. BEGGS. Well, I don't think you'd have to worry about it. You know, they don't sell very well, and the reason they don't sell very well is that they're not oriented to customers. They have no customer orientation. They do things in a very bureaucratic way, and as a consequence, very few customers trust them to do the kind of job. That's why—you know, they've tried for years—and I've seen this in the world, around the world—they've tried for years to sell their commercial transports, their air transports into the world market. They have been universally unsuccessful. Now, their transports aren't all that good, but recently they've been turning out some reasonably decent air transports, and they sell them for very attractive prices. But the problem they've had is that either by reason of their inability to change their system, or by reason of their unwillingness to even think about customer requirements, their service is dismally poor. Nobody is going to buy a commercial transport unless he's assured of servicing. He needs spare parts, he needs a system that if he can't get a spare part and he's sitting out there in Calcutta, India, he wants somebody to fly it to him. And you've got to have that system set up or you don't sell any air transports. And that's their problem. And if they'd open up wider, I think it would be a great thing for the world.

Mr. WALKER. Thank you.

Mr. NELSON. OK. If there are no further questions, we will recess the hearing and we will go vote, and then we will have Dr. Lubin, Project Director of the OTA. And Mr. Beggs, we thank you. I look forward to visiting with you. Have a good day.

[Whereupon, a brief recess was taken.]

Mr. NELSON. The committee will resume. Dr. Nancy Lubin, who is the Project Director of the Office of Technology Assessment Special Report, United States-Soviet Cooperation in Space. Dr. Lubin.

STATEMENT OF JOHN ANDELIN, OFFICE OF TECHNOLOGY ASSESSMENT

Mr. ANDELIN. Mr. Chairman, I'd like to introduce a few of the OTA staff. I'm John Andelin, Assistant Director of OTA. We very much appreciate the opportunity to share with you the results of our technical memorandum on United States-Soviet Cooperation in Space.

I'd like to take a moment to describe an OTA technical memorandum, and to tell you something of the background of this one.

First, a technical memorandum is less ambitious, but not less carefully done, than a full technology assessment. It usually draws on past or current work at OTA. For example, the technical memorandum that Dr. Lubin will summarize this morning draws upon our work on space science and applications, the civilian space station, and cooperation and competition in space.

Second, a technical memorandum explores the issues involved in making a decision about a legislative concern, but does not set out a series of policy options as a longer study would ordinarily do.

This particular technical memorandum was requested by Senators Matsunaga, Mathias, and Pell. It was preceded by a document reporting the results of a workshop of space scientists familiar with the realities of cooperating with the Soviet space scientists. Though we've drawn upon information from the expert community in academia, and the public and private sectors, the analysis and conclusions of U.S.-Soviet Cooperation in Space are OTA's alone.

With me today, in addition to Dr. Lubin, are Nancy Naismith, the program manager responsible for the supervision and direction of the study; B.J. Tatum, the research assistant; Dr. Peter Sharffman, program manager in a different program; and some of our press staff as well.

In addition to our prepared testimony we are pleased to answer any and all questions about either OTA itself or this particular memorandum.

[The prepared statement of Mr. Andelin follows:]

We appreciate the opportunity to share with you the results of our Technical Memorandum on United States-Soviet Cooperation in Space.

Let me take a moment to describe an OTA "Technical Memorandum," and to tell you something of the background of this one.

First, a T.M. is less ambitious, but not less carefully done, than a full Technology Assessment—usually drawing upon past or current work at OTA. For example, this Technical Memorandum that Dr. Lubin will summarize this morning draws upon our work on Space science and applications, the Civilian Space Station, and Cooperation and Competition in Space.

Second, a Technical Memorandum explores the issues involved in making a decision about a legislative concern, but does not set out a series of "Policy Options", as a longer study would ordinarily do.

This particular Technical Memorandum was requested by Senators Matsunaga, Mathias and Pell. It was preceded by a document reporting the results of a workshop of space scientists familiar with the realities of cooperating with Soviet space scientists. Though we have drawn upon information from the expert community in academia, and the public and private sector, the Analysis and Conclusions of United States-Soviet Cooperation in Space are OTA's alone.

With me today are other OTA staff with responsibilities for space—Nancy Naismith, the OTA Program Manager responsible for supervision and direction of this study; Dr. Nancy Lubin, Project Director for the study, who will summarize our Technical Memorandum for you today; B.J. Tatum, research assistant; and Dr. Peter Sharffman, P.M. of ISC—in addition to our prepared testimony, we are, of course, prepared to answer any questions you may have about OTA or this study.

STATEMENT OF NANCY LUBIN, PROJECT DIRECTOR, OFFICE OF TECHNOLOGY ASSESSMENT

Dr. LUBIN. Thank you. Mr. Chairman, we're pleased to provide testimony today for the subcommittee. It's our hope that the technical memorandum we released last week on United States-Soviet cooperation in space will be helpful to the subcommittee as it considers the difficult questions involved.

As we heard this morning, against a background of both tentative steps toward cooperation and very real tension and competition between the two countries, the question of United States-Soviet cooperation in space is a very complex and a very controversial one. OTA's technical memorandum focuses on four issues that are central to this question—the scientific, the foreign policy, the national security issues, and then questions of Soviet motivations and Soviet behavior.

The first issue is whether United States-Soviet space cooperation can be valuable from a scientific and/or practical point of view. OTA's analysis revealed an unequivocal yes in certain areas of space science research. Because of different orientations in the United States and Soviet space programs, most U.S. space scientists agree that United States-Soviet space cooperation is especially valuable in the life sciences and planetary research.

The Soviet emphasis on extended manned spaceflight, for example, makes Soviet research especially valuable in examining such questions as the effects of long duration flight on bone loss and cardiovascular deconditioning. The U.S. Space Program tends to focus on more short-term missions. And in a broader sense, United States-Soviet cooperation in space can also enhance U.S. insight into the Soviet space program and into Soviet society as a whole. We've heard some testimony on this, this afternoon.

The second issue, the foreign policy, is more controversial. Despite the scientific and the practical benefits that may be obtained from United States-Soviet space cooperation, the issue of cooperation in space is fundamentally a foreign policy one. It was for foreign policy reasons that the United States-Soviet space cooperation was initiated in the first place; it was for foreign policy reasons—the human rights issues, the declaration of martial law in Poland, and the Soviet invasion of Afghanistan—that the space agreement was allowed to lapse in 1982. And it's primarily because of foreign policy reasons today that the issue of space cooperation is once again being initiated and discussed.

These reasons include the use of space cooperation to reduce tensions between the two superpowers or offset the arms race, and the use of the symbolic value of space cooperation to achieve other foreign policy goals, perhaps unrelated to space.

Past experience suggests that while foreign policy does affect the direction of United States-Soviet space cooperation, the reverse does not necessarily follow. Space cooperation may be one means of

keeping lines of communication open with the U.S.S.R., and it may be a good means of sustaining good relations. But there is no evidence from the past that it can, in its own right, redirect or reshape that relationship in any far reaching or significant way.

For example, one of the hopes behind the start of space cooperation in the 1960's and the 1970's, and certainly behind the Apollo-Soyuz mission in 1975, was the possibility of a reduction in tension and in the military build-up of both sides. The mid-1970's, however, saw not only the launching of Apollo-Soyuz, but also the beginning of the Soviets' second phase of the testing of their Asat weapon, the development of Soviet Rorsat's—their nuclear reactor powered radar ocean reconnaissance satellites—and a great deal of importance placed on military space systems in both countries. In purely political terms, the ASTP was soon followed by a sharp deterioration in United States-Soviet relations overall.

Other foreign policy questions are also controversial. Chief among these is the question of whether it's smart to exploit the symbolic value of United States-Soviet space cooperation to achieve other U.S. foreign policy goals. There is no doubt, for example, that the symbolism of space cooperation with the U.S.S.R. can send positive messages to the rest of the world, which are in the interest of the United States, by demonstrating to other countries our desire to work with our adversaries to promote peace.

But it can also send messages that the United States doesn't find in its own interests: As at the time of Apollo-Soyuz, it may provide the U.S.S.R. with a great deal of benefit by casting them as technologically equal to the United States, and should a large scale joint project fail, the symbolic cost could also be damaging to the U.S. interests.

Likewise, controversy remains great over whether space cooperation should be turned on or off in response to other political events, as it was in 1982. The potential costs and benefits deriving from the symbolism of United States-Soviet space cooperation, as a whole, would generally increase with the size, the scale, and the visibility of any cooperative effort.

The third key issue in any United States-Soviet space cooperation activity is the question of technology transfer. Recent experience, in both low level, informal space cooperation with the U.S.S.R. and also in space cooperation with our allies, suggests that technology transfer will remain a major concern in any further space cooperation with the Soviet Union, regardless of the level on which cooperation occurs.

This issue stems from a conflict between two important national interests in our own country. On one side the Soviets have been pursuing an aggressive campaign to acquire Western technology and know-how, particularly in the area of space systems and space technology. Severely limiting cooperation in space is often considered one approach to protecting Western security against these efforts.

But on the other side, overly stringent controls could threaten the free interchange of scientific and technical ideas and information in areas that, as we saw this afternoon, are complementary to, but not always addressed in, the U.S. space program. And since the Soviets are already cooperating with other Western countries in

space research and application, the United States could find it increasingly difficult to control the flow of information to the U.S.S.R. without isolating itself from the rest of the world space community.

Few would argue against caution in United States-Soviet cooperation in space, but the details of the limits and the mechanisms of that control are what's contested. The current administration has implemented more controls than its predecessors over the transfer of technology and of information. We have a small box in the report that outlines some of the more major directives and pieces of legislation.

Many scientists, though, are concerned that these controls and related self-censorship among some scientists could threaten the free interchange of ideas among space scientists around the world, and ultimately could prove counterproductive to our own U.S. interests.

As illustrated in recent congressional hearings on export controls, tech transfer is an exceedingly controversial issue with little agreement within the Congress itself, or the administration. Our chief challenges will be not only to sort out what should be considered militarily sensitive, but who should be making these judgment calls, and the extent to which sensitive technology can be utilized and protected in order for future cooperation in space to be effective.

Finally, the fourth issue concerns Soviet motivations and behavior. U.S. planners cannot unilaterally make decisions concerning the amount, the type, or the scope of space cooperation which should take place. Soviet official policy has always expressed, and it continues to express, a commitment to cooperation in space. But Soviet policy also explicitly underlines that the issue of space cooperation is an integral part of Soviet foreign policy overall.

Thus, Soviet political leaders have consistently used their own space program not only to enhance cooperation, but to pursue other foreign policy objectives which are more competitive and more confrontational in nature; such as using space to enhance their own prestige and influence, portraying the United States as a threat to international peace, and deflecting attention from the military character of the Soviet space program onto that of the United States.

As a result, tensions in United States-Soviet relations today are reflected in an official Soviet hardline, albeit somewhat ambiguous, approach toward space cooperation with the United States. Soviet officials and scientists informally suggest that United States-Soviet space cooperation would be valuable. But they have not officially responded, as we saw this afternoon, to recent overtures to renew such cooperation.

Despite publicity in the United States surrounding experiments onboard the Venus-Halley mission, the Soviet press has either avoided mentioning or else explicitly denied that there is any U.S. participation in this mission. And Soviet officials have also politicized the issue by emphasizing the severe, if not the insurmountable, constraints that the U.S. strategic defense initiative places on starting any major United States-Soviet space cooperation.

In more general terms, it's important to recognize that Soviet decisions are tied up with both domestic and foreign policy concerns that are often quite different from those in the United States. In a society where ideas and contacts with foreigners are tightly controlled, and where the area of space itself is heavily dominated, if not run, by the military, the Soviets tend to set their own criteria for judging the merits of cooperation very high. This makes it all the more important that U.S. policymakers assess precisely what U.S. objectives in fact are from space cooperation, and assess how those can be attained independent of what we believe the Soviets might want in Moscow.

I should point out in closing that other countries are also grappling with these same issues, and often come down in different places from where we do. In France, for example, where space cooperation with the U.S.S.R. is extensive, French planners tend to play down the political symbolism while emphasizing the scientific foundation of cooperation, and tend to have more liberal assessments of what may constitute a technology transfer concern. But the French are also the first to point out that their needs are different from our own, and also their status on the world stage is very different from our own. So, it's much easier for them to avoid this symbolism than it would be for Washington.

In assessing what U.S. policy should be, then, several factors—the conflicts between the gains of cooperation and the risks of technology transfer, disagreement over the relative importance of scientific and practical benefits and foreign policy goals, and possible inconsistencies among those foreign policy goals themselves—suggest that there will always be a multiplicity of views about United States-Soviet cooperation in space. The ways in which these viewpoints are reflected in policy will determine the size, the shape, the scope, and the effectiveness of any potential space cooperation with the U.S.S.R.

It would clearly be useful to further examine the costs and benefits of such cooperation as a basis for considering the establishment, the cancellation, or the continuation of cooperative arrangements in the future. At the same time, though, it is important to remember that views on how much cooperation to pursue will necessarily reflect judgments about broader issues of world tensions, Soviet objectives, and the overall course of United States-Soviet relations overall, at least as much as they will reflect judgments about the costs and benefits of United States-Soviet cooperation itself.

[The prepared statement of Dr. Lubin follows:]

U.S.-SOVIET COOPERATION IN SPACE

Statement of Dr. Nancy Lubin, Project Director
Office of Technology Assessment

Accompanied by Dr. John Andelin, Assistant Director
Nancy C. Naismith, Program Manager
Office of Technology Assessment

Hearing before the House Committee on Science and Technology
Subcommittee on Space Science and Applications

July 30, 1985

U.S.-Soviet Cooperation in Space

Mr. Chairman: The Office of Technology Assessment is pleased to provide testimony today for the Subcommittee. It is our hope that the Technical Memorandum released last week on U.S.-Soviet Cooperation in Space will be helpful to the Subcommittee as it considers these difficult questions.

The question of U.S.-Soviet cooperation in space is a very complex and controversial one. OTA's Technical Memorandum focuses on four issues that are central to this question: the scientific, foreign policy, and national security issues, and questions of Soviet motivations and behavior.

The first issue is whether U.S.-Soviet space cooperation can be valuable from a scientific and/or practical point of view. OTA's analysis revealed an unequivocal "yes" in certain areas of space science research. Because of different orientations in the U.S. and Soviet space programs, most U.S. space scientists agree that U.S.-Soviet space cooperation is especially valuable in the life sciences and planetary research. The Soviet emphasis on extended manned spaceflight, for example, makes Soviet research especially valuable in examining such questions as the effects of long duration flight on bone loss and cardiovascular deconditioning. (The U.S. space program is focused on more short term missions). And in a broader sense, U.S.-Soviet cooperation in space can also enhance U.S. insight into the Soviet space program and Soviet society as a whole.

A second issue -- foreign policy -- is more controversial. Despite the scientific and practical benefits that may be attained from U.S.-Soviet space cooperation, the issue of cooperation in space with the U.S.S.R. is primarily one of foreign policy. It was for foreign policy reasons that U.S.-Soviet cooperation in space was initiated in the first place; it was for foreign policy reasons -- i.e., human rights issues in the late 1970s, the Soviet invasion of Afghanistan, and ultimately, the declaration of martial law in Poland -- that the space agreement was allowed to lapse in 1982; and it is because of foreign policy reasons that the issue of space cooperation with the U.S.S.R. is once again being discussed. These reasons include the use of space cooperation to reduce tensions between the two superpowers or offset the arms race, and the use of the symbolic value of space cooperation to achieve other foreign policy goals unrelated to space.

Past experience suggests that while foreign policy does affect the direction of U.S.-Soviet space cooperation, the reverse does not necessarily follow. Space cooperation may be one means of keeping lines of communication open with the U.S.S.R., and sustaining good relations. But there is no evidence that it can, in its own right, re-direct or re-shape that relationship in any farreaching or significant way.

For example, one of the hopes behind the start of space cooperation in the 1970s, and certainly behind the Apollo Soyuz mission in 1975, was the possibility of a reduction in tension and in the military buildup of both sides. The mid 1970s, however, saw not only the launching of Apollo Soyuz, but also the beginning of the Soviets' second phase of testing of their ASAT weapons, the development of Soviet RORSATs (nuclear reactor powered radar ocean reconnaissance satellites), and a great deal of importance placed on military space systems in both countries. In purely political terms, the ASTP was soon followed by a sharp deterioration in U.S.-Soviet relations overall.

Other foreign policy questions are also controversial. Chief among these is the question of whether it is smart to exploit the symbolic value of U.S.-Soviet cooperation in space to achieve other U.S. foreign policy goals. There is no doubt, for example, that

the symbolism of space cooperation with the U.S.S.R. can send positive messages to the rest of the world in the interest of the U.S., by demonstrating to other countries our desire to work with our adversaries to promote peace. But it can also send messages that the U.S. does not find in its interests: 1) it may provide the U.S.S.R. with a great deal of benefit by casting them as the technological equal of the United States; and 2) should a large scale joint project fail, the symbolic cost could be damaging to U.S. interests. Likewise, controversy remains great over whether space cooperation should be turned on or off in response to other political events as it was in the early 1980s. The potential costs and benefits deriving from the symbolism of U.S.-Soviet space cooperation would generally increase with the size, scale and visibility of any cooperative effort.

The third key issue in any U.S.-Soviet space cooperation activity is the question of technology transfer. Recent experience -- in both low-level, informal space cooperation with the U.S.S.R. and in space cooperation with our allies -- suggests that technology transfer will remain a major concern in any further space cooperation with the U.S.S.R., regardless of the level on which cooperation occurs. This issue stems from conflict between two important national interests. On one side the Soviets have been pursuing an aggressive campaign to acquire Western technology and know-how, particularly in the area of space systems and technology; severely limiting cooperation in space is one approach to protecting Western security against such efforts. But on the other side, overly stringent controls could threaten the free interchange of scientific and technical ideas and information in areas complementary to, but not always addressed in, the U.S. space program. And since the Soviets are already cooperating with other Western countries in space research and applications, the U.S. could find it increasingly difficult to control the flow of information to the U.S.S.R. without isolating itself from the rest of the world space community.

Few would argue against caution in U.S.-Soviet cooperation in space, but details of the limits and mechanisms of control are contested. The current Administration has

implemented more controls than its predecessors over the transfer of technology and of information. Many scientists are concerned that these controls, and related self-censorship among some scientists, could threaten the free interchange of ideas among space scientists around the world and, ultimately, could be counterproductive to U.S. interests.

As illustrated in recent congressional hearings on export controls, technology transfer is an exceedingly controversial issue, with little agreemeent within the Congress or the Administration itself. Our chief challenges will be to sort out what should be considered militarily sensitive, who should be making these judgment calls, and the extent to which sensitive technology can be utilized and protected in order for any future cooperation in space to be effective.

Finally, **the fourth issue concerns Soviet motivations and behavior.** U.S. planners cannot unilaterally make decisions concerning the amount, type and scope of space cooperation which should take place. Soviet official policy has always expressed and continues to express a commitment to cooperation in space. But Soviet policy also explicitly underlines that the issue of space cooperation is an integral part of Soviet foreign policy overall. Thus, Soviet political leaders have consistently used their space program not only to enhance cooperation, but to pursue other foreign policy objectives more competitive or confrontational in nature, such as using space to enhance their own prestige and influence; portraying the United States as a threat to international peace; and deflecting attention from the military character of the Soviet space program onto that of the United States.

As a result, tensions in U.S.-Soviet relations today are reflected in an official Soviet hardline, albeit somewhat ambiguous, approach towards space cooperation with the United States. Soviet officials and scientists informally suggest that U.S.-Soviet space cooperation would be valuable. But they have not officially responded to recent overtures to renew such cooperation. Despite publicity in the U.S. surrounding American

experiments on board the Venus Halley mission, the Soviet press has either avoided mentioning or explicitly denied that there is any U.S. participation in this mission. And Soviet officials have also politicized the issue by emphasizing the severe, if not insurmountable, constraints the U.S. Strategic Defense Initiative places on starting any major U.S.-Soviet space cooperation.

In more general terms, it is important to recognize that Soviet decisions are tied up with both domestic and foreign policy concerns that are often quite different from those in the United States. In a society where ideas and contacts with foreigners are tightly controlled -- and where the area of space is heavily dominated by the military -- the Soviets tend to set their own criteria for judging the merits of cooperation very high. This makes it all the more important that U.S. policymakers assess precisely what U.S. objectives from space cooperation are, and assess how they can be attained independent of possible Soviet intentions.

I should point out in closing that other countries are also grappling with these same issues, and often come down in different places from where we do. In France, for example -- where space cooperation with the U.S.S.R. is extensive -- French planners tend to play down the political symbolism while emphasizing the scientific foundation of cooperation, and tend to have more liberal assessments of what may constitute technology transfer concerns. But the French are also the first to stress that their needs and their status on the world stage are also quite different from ours.

In assessing what U.S. policy should be, then, several factors -- the conflicts between the gains of cooperation and the risks of technology transfer; disagreement over the relative importance of scientific and practical benefits and foreign policy goals; and possible inconsistencies among foreign policy objectives -- suggest that there will always be a multiplicity of views about U.S.-Soviet cooperation in space. The ways in which these viewpoints are reflected in policy will determine the size, shape, scope and effectiveness of any potential space cooperation with the U.S.S.R.

It would clearly be useful to further examine the costs and benefits of past cooperation, as a basis for considering the establishment, cancellation or continuation of cooperative arrangements in the future. At the same time, however, it is important to remember that views on how much cooperation to pursue will necesarily reflect judgments about broader issues of world tensions, Soviet objectives, and the overall course of U.S.-Soviet relations at least as much as they will reflect judgments about the costs and benefits of U.S.-Soviet space cooperation itself.

Mr. NELSON. Dr. Lubin, another vote has been called, and rather than holding you here until I get back, we will make a part of the record your written report, and we appreciate it very, very much.

I listened very carefully and you have some very stimulating thoughts there. And I think that your final suggestion that we ought to clearly have in mind what are our goals, and they ought to be articulated and defined and understood, as a matter of U.S. policy, I think that's a very salient suggestion, and we appreciate it.

We'll look forward to continuing the hearings tomorrow. The meeting is adjourned.

[Whereupon, the hearing was adjourned at 3:45 p.m.]

ASSESS POTENTIAL GAINS AND DRAWBACKS OF CIVILIAN SPACE COOPERATION WITH THE SOVIETS

WEDNESDAY, JULY 31, 1985

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:45 a.m., in room 2318, Rayburn House Office Building, Hon. Bill Nelson (chairman of the subcommittee) presiding.

Present: Representatives Nelson, Lujan, Andrews, and Meyers.

Mr. NELSON. The committee will come to order.

Good morning. We have a very full day today. It's already been a full day today. I have already been to one committee testifying this morning.

Interestingly, if you take our tax laws here on Earth on such things as investment tax credit, accelerated depreciation, R&D tax credits, treatment of income as domestic income—these are the tax laws that apply to business activity on Earth. But those tax laws don't apply to business activity in space. So I have been before the Ways and Means Committee this morning trying to get that straightened out.

Without objection, we will have unanimous consent that the media and communications equipment are allowed for purposes of reporting this hearing.

We have a very full day. The State Department was unable to be with us yesterday, so we are going to kick off the meeting with the Deputy Assistant Secretary for Science and Technology, Mr. Charles Horner.

We are delighted to have you.

Then we are going to have our Apollo-Soyuz ASTP astronauts Deke Slayton and Vance Brand.

General Stafford is out of town, but his testimony will be a part of the record.

Vance Brand, as everyone knows, is still a member of our astronaut corps at the Johnson Center. Later in the day, we will have a panel of eminent scientists representing different disciplines. All have been involved on a professional level with Soviet scientists and projects.

We are most interested in the problems, risks, and rewards of working with the Soviet scientists as well as the importance of a cooperative agreement. We want to look at the totality of this. We

start with no preconceived notions except that which is instinctive within us, recognizing that space is a unique environment in which adversaries can cooperate. So that is the only preconception that we start with. We start also, obviously, with the historical record that we know of the tremendous success of our mission of ASTP 10 years ago.

So, Mr. Horner, we will start with you. It is my style that we will put your testimony as a part of the official records, and I would prefer that rather than you read it word for word, that you just converse with us, give us your ideas, and then we can have some dialog after your comments.

Please proceed.

STATEMENT OF CHARLES HORNER, DEPUTY ASSISTANT SECRETARY OF STATE FOR SCIENCE AND TECHNOLOGY, DEPARTMENT OF STATE

Mr. HORNER. Thank you very much, Mr. Chairman. I am pleased to be here this morning to discuss with you and with the members of the subcommittee the Department of State's views on this subject.

As you know, we are entering into a period of high-level political discussion and contact between ourselves and the Soviets. The Secretary of State is now in Helsinki, and the President will meet with General Secretary Gorbachev sometime in November.

The purpose of this activity, of course, is to see whether or not we can develop a more productive and more stable relationship with the Soviet Union. Both from past history, as you mentioned, and from future possibilities, joint activity in space might be one of those areas where that kind of relationship could be given some practical effect.

I think it's been clear, however, at that time and now that the prospects for cooperation in space with the Soviets are determined, in large measure, first by the general state of Soviet-American relations, and second, what is practically possible given the nature of the Soviet system, given the concerns we have not only about the unwarranted transfer of technology but also the experience we've had in the lack of reciprocity and difficulties in access to certain Soviet institutions and individuals.

These are the things which we will have to balance out as time goes on. I think everyone realizes that the Soviet Union has a very ambitious and very successful space program, with great achievement in certain areas, perhaps lesser achievement in others.

We know that this is of great interest to our scientific community. But generally speaking, from the point of view of United States foreign policy, we will have to proceed with some care to make sure that our interests and concerns are adequately protected in whatever developments come about with the Soviets in outer space cooperation.

I think that represents the gist of our view of the matter. I would be perfectly happy to answer questions that you might have.

[The prepared statement of Mr. Horner follows:]

Statement by Charles E. Horner
Deputy Assistant Secretary for
Science and Technology
Before the House Subcommittee on Space
Science and Applications

July 31, 1985

Mr. Chairman,

I welcome the opportunity to discuss with you and the Members of the Subcommittee the Department of State's views on U.S.-Soviet civil space cooperation.

As you know, there are high-level political discussions ongoing with the Soviet Union. President Reagan and General Secretary Gorbachev will meet in November, and Secretary Shultz is now in Helsinki, where he will meet with Foreign Minister Shevardnadze to discuss the issues affecting our two nations. The major purpose of the United States at these meetings is, of course, the development of more stable and productive relations with the Soviet Union. At the top of our agenda is the need to find ways to reduce stockpiles of nuclear weapons.

But there are also a number of areas of U.S.-Soviet relations which could offer opportunities for progress. Down the road, joint civil activities in space might be one of these. Before describing our thinking on the future prospects

for joint space undertakings with the Soviet Union, however, I would like to offer some observations on the nature of past efforts in this field.

As you know, we did not renew the agreement with the Soviets on "Cooperation in the Exploration and Use of Outer Space" in response to the Soviet role in the imposition of martial law in Poland. The Agreement expired in May, 1982. Two months later we did not renew our agreements in Energy and in Science and Technology to express our continuing opposition to the Soviet Union's occupation of Afghanistan, as well as our deep concerns with its continuing role in the repression in Poland.

While past joint activity in scientific and technological fields has obviously not restrained Soviet geopolitical and military ambitions, we believe cessation of cooperative agreements between the Soviet's 1979 invasion of Afghanistan and the Korean Airlines incident in late 1983 helped send a necessary strong message to the Soviets about this unacceptable behavior.

Against this background, the Department believes that joint projects in space must be carefully formulated in the context of our overall relations with the Soviets; they are not separable. As the President remarked in his June 27, 1984 speech to participants in the Smithsonian's Conference on U.S.-Soviet Exchanges, "when Soviet actions threaten the peace or violate a solemn agreement or trample on standards fundamental to the civilized world, we cannot and will not be silent. We must have ways short of military threats that make it absolutely clear that Soviet actions do matter and that some actions inevitably affect the quality of the relationship."

Nevertheless, our reactions may lead to a decrease in our contacts with the people of the Soviet Union. This is a dilemma, which is to say that, while oftentimes finding it necessary to limit our dealings with the Soviet Government, we do not want to decrease or reduce contacts with the people of the Soviet Union. Given the nature of the Soviet regime, this can be a difficult dilemma to resolve.

Accordingly, we have encouraged the Soviet Union over the past year, to join with us in a major effort to establish a better working relationship. We have made comprehensive and specific proposals. In the field of space, we have proposed a

joint simulated space rescue mission. In response, the Soviets have made clear they do not consider substantive discussion appropriate for the time being. Similarly, on October 30, 1984, President Reagan signed a statement addressing our longterm interests in East-West ventures in space. In so doing, the President re-affirmed our desire to increase contacts with the Soviet Union and our readiness to work with the Soviets on programs which are mutually beneficial and productive.

The American scientific community and technical agencies of the United States Government remain interested in joint activities with their Soviet counterparts in space research where such efforts are balanced, mutually beneficial and can lead to concrete scientific or technical results. Both governments have continued active support of cooperation in Soviet biosatellite missions, with NASA providing technical support to assist Soviet scientists in obtaining cardiovascular and biorhythm measurements, in exchange for NASA's access to the data. This type of research -- in space biology and medicine -- is one example available for mutually beneficial and productive joint endeavors. Another is our ongoing cooperation with the Soviet Union in the field of satellite-

aided search and rescue in which NOAA's polar-orbiting spacecraft play a prominent role. Finally, under a tracking and data acquisition agreement among NASA, ESA, Japan and the Soviet Union, NASA is tracking the Soviet's Venus-Halley (Vega) spacecraft.

In the Department's view, future projects -- like those which I have just noted -- should be scientifically sound and technically valid; they should draw on unique Soviet capabilities in this area, and should be carefully designed to avoid ill-advised technology transfer in order to meet our objective of mutual benefit and reciprocity in our S&T exchange. The contributions each side is to make to a joint program must be carefully evaluated and kept in balance, and the work must be carefully monitored to ensure that each side is keeping its commitment scrupulously. As we work with the Soviets in space exploration as in every other area of scientific and technological exchange, we must ensure that the closed nature of Soviet society does not lead to an imbalance of benefits in the Soviets' favor. Thus, we must ensure that in our programs with the Soviets there is a strict balance in terms of access to necessary institutes, facilities, people, and data.

The Department of State is committed to improving opportunities for balanced endeavors with the USSR in the field of space. As part of this effort, we have put forward a proposal on space rescue for the Soviet Union's consideration. We believe that proposal and similar programs, if structured along the lines I have just described, could offer practical benefits for all mankind.

This does not mean that we have forgotten actions by the Soviet Union which have led to the downgrading of bilateral cooperation between our two countries. We will continue to demonstrate our deep opposition to and concern over such actions. And, we also have to recognize that the nature of US-Soviet relations will continue to be adversarial. At the same time, both we and the Soviet Union have a stake in placing our bilateral relationships on a sounder footing. We have demonstrated the clear willingness of the United States to establish a better relationship with the Soviet Union in civil space activities. We hope that, in time, the Soviet Union will come to share a similar interest. We will continue to study possibilities for expanding contacts and joint activities with the Soviets in this area, contacts which are mutually beneficial and productive, and consistent with the state of our overall bilateral relations.

1934s

DEPARTMENT OF STATE

Washington, D.C. 20520

CHARLES HORNER

Charles Horner has been Deputy Assistant Secretary of State for Science and Technology since October 1981. Previously, he had been Adjunct Professor and Research Associate of the Landegger Program in International Business Diplomacy in Georgetown University's School of Foreign Service. He was also a member of the United States Delegation to the United Nations Conference on the Law of the Sea. His earlier service in government had been in the United States Senate, where he was a member of the professional staff of the Subcommittee on National Security and International Operations and, later, senior legislative assistant in the office of Senator Daniel P. Moynihan.

Horner is a graduate of the University of Pennsylvania and did post-graduate work at the University of Chicago. He also studied overseas in Taiwan and Japan.

Horner is married and has two children.

Mr. NELSON. It is no secret—as a matter of fact, I have talked at the highest levels in the White House about this—that this committee wants to go to the Soviet Union as a followup ceremony for Apollo-Soyuz. If the invitation is forthcoming from the Soviets, then our primary guests will be our three American astronauts from ASTP to have a reunion in the Soviet Union.

Do you want to give us any State Department thinking on how that might help or not at this particular time?

Mr. HORNER. Well, quite frankly, I am not aware of the prospect of such an invitation, so I don't know exactly what I ought to say about it here.

In general, as you know, there is a very wide range of congressional interest and congressional contact and congressional visiting in the Soviet Union. It's a well-established practice.

Mr. NELSON. Well, we're getting some positive vibes from the Soviets. We also got some very positive vibes from my checking it out at various levels in the executive branch as well. So you might keep that in mind and talk about it among your colleagues. And let me know if you get any definite feelings one way or another.

Let me ask you about the Soviet response, or lack thereof, to the administration's proposal to undertake a simulated joint space rescue mission. What did the Soviets actually say, if anything? And is there any basis to expect any kind of changes in the near future?

Mr. HORNER. Well, it isn't clear how their attitude might change. I think their response, which takes advantage of normal diplomatic circumlocutions in this area, but was essentially one of noninterest, I think, coupled with what has become, as you know, a common feature of Soviet pronouncements on space and space-related subjects, indeed even going back to the time of the Space Shuttle Pro-

gram itself, the allegation that the United States is engaged in improper activities in space which ought to cease.

I think that has been a recurring theme of Soviet public pronouncements about the U.S. Space Program in general for some time, and so in that sense, is not surprising.

There has been a great effort on their part to characterize the U.S. Space Program in a certain way, and therefore it may be the case that they do not wish to appear eager to cooperate with it lest they seem to be affording some sort of legitimacy to something that has been the object of a sustained propaganda assault by them.

Mr. NELSON. Do you think that cooperation, space cooperation, with the Soviets from your perspective as a Foreign Service officer, does that contribute in any way to the political climate between the two countries? And looking back on the experience from your perspective as a Foreign Service officer, what; by most measures, is considered the outstanding success of ASTP. What was the effect upon the political climate?

Mr. HORNER. Well, I think it's very hard to draw a correlation between what we do with the Soviets in space on the one hand and what they do in certain parts of the world on the other.

One doesn't like to recall unhappy occurrences, the time of the Apollo-Soyuz flight in December of 1975 that came shortly after a massive Soviet contribution to the North Vietnamese violation of the Paris peace accords, which led to the overrunning of the independent countries at or about the same time, I think it was, in 1975 there was a great—I don't know what the right word is—efflourescence of Soviet neoimperialistic activity in various parts of the world, in Angola and Ethiopia and Aden and so on, continuing on through the 1970's through the invasion of Cambodia by the North Vietnamese, and Afghanistan, and suppression in Poland and all of these things.

So it is very hard to say that a given amount or relation or quality of United States-Soviet cooperation in space or in any other area of science is going to have much practical effect on Soviet geopolitical behavior. That's the difficulty of it.

It is also the case, even in the more limited area when we talk about activities in space itself, that at the same time this peaceful activity was going on, there was a great burst of Soviet activity in antisatellite weapons, testing, and things of that sort. So it's even difficult to draw a correlation between military-related activities in space and scientific and civil cooperation on the other.

At the same time, of course, one would be wrong to say that cooperation in space causes these other bad things to happen. It is a difficult correlation to make, I think, and we don't really have any evidence for the proposition that increased cooperation in this area will result in better relations elsewhere.

Mr. NELSON. Do you think the 1982 agreement ought to be reinstated?

Mr. HORNER. Not yet.

Mr. NELSON. Why?

Mr. HORNER. Well, I think that one has to look at the set of circumstances which led us to conclude that continuing the 1982 general agreement wasn't appropriate. It's a question of what follows. From the point of view of foreign policy, we are interested in the

overall state of political relations between ourselves and the Soviet Union, and we are interested in those relations—we are interested in measuring improvement in those relations in the form of concrete deeds.

Now, just yesterday the Secretary of State spoke at some length at the Helsinki commemoration about the difficulties that still exist in Soviet compliance with those agreements. And so I think that if, in the future, one sees prospects for improvement in the political relation that would justify picking up this agreement again, I think that would be something that we would explore. But I don't think it's possible for us to consider these propositions in isolation. That's the difficulty.

The agreement itself may be a worthwhile agreement, it may have led to interesting and productive activities in the realm of science, but unfortunately we can't consider it solely in that isolated way.

Mr. NELSON. So you are saying let the political climate improve and then we will consider the renewal of the agreement?

Mr. HORNER. Well, I think it's one of the things that's possible if these renewed efforts to establish a more stable and productive relationship with the Soviets bear some fruit.

Mr. NELSON. Right now, there is almost a cynicism that's being expressed about Helsinki. There has been a lot of press, indeed, in the Washington Post, about the failings of the Helsinki accords. Why would you think that there could be a breaking of new ground in November in the summit, and how might this area of space help—well, let me just stop there.

Mr. HORNER. Well, so far as the meetings between the heads of Government are concerned, it's been the policy of the administration since its beginning to do what it can to seek improved relations with the Soviets in a balanced and sensible way, and one doesn't know what comes of all of these efforts, but I think as has been indicated, the administration wants to do what it can, is willing to go what has become known as "the extra mile" in the hope that we can get some comparable response from the Soviets on many of these outstanding matters. What the guarantee of success is, I don't know. I don't know how one would rate the prospects for success.

Mr. NELSON. I guess it was, oh, probably 6 months ago that the President released a statement in which he said that many different violations had occurred on arms control agreements. My question would be, if, in fact, we assume the accuracy of that statement on the violation of the arms control agreements in the past, then why would we think that any new cooperative agreements, particularly a space cooperative agreement, would not have similar kind of violations?

Mr. HORNER. Well, I think in the first place, one ought to distinguish between an arms control agreement which deals with certain subjects and establishes certain procedures and has some very important stakes, and one that has to do with science cooperation.

Now, it's true that one of the things that has been unfortunate in our experience with the Soviets in some of these agreements have had to do with some of the points I have mentioned; for example, access, appropriate sharing of data, all of those kinds of things.

The only reason one can expect the Soviets to live up to any agreement is if they calculate that they are better off living up to it than not living up to it. I don't think that it's a point of principle with them. And to the extent that they think that it is in their interest to comply with an agreement, they will, and to the extent that they feel that they are better off not and will not suffer any particular penalty for not complying with it, they won't.

I think that applies across-the-board even though the stakes and the intrinsic importance of some of these matters would be quite different.

Mr. NELSON. I would like your views on something that came out of yesterday's hearing. It was very interesting, in talking with Jim Beggs, the Administrator of NASA. He revealed how we continue to have the scientific contacts but so often they're having to go through third parties because there is no formal working relationship. The agreement lapsed in 1982. Thus, as we have contributed to the scientific experiments on the Vega spacecraft, we've done that through third parties. We haven't done it Government to Government, agency to agency.

What is your opinion as to the advantage or disadvantage of that kind of working relationship in continuing the science contacts and the science exchanges?

Mr. HORNER. Well, in a system such as our own and in a society such as our own, there is a large sphere of independent activity, if you will, that individuals, universities, institutions, and others carry out that is not controlled by the Government, whereas in the Soviet case, of course, the Government monopolizes all of these contacts.

So one could assume that in a certain sense, the United States is disadvantaged by its decentralized system and its decentralized arrangements. Whether or not a new agreement with the Soviet Union would allow the Federal Government to exercise more direction, if that's the polite term, over the actions and contacts of individuals, I am not sure. And I am not even sure whether that would be a good thing, and I am not even altogether sure whether the people who are pursuing these things independently now would welcome that as a practical fact. I think they might welcome it as a political fact. They might welcome the political symbolism of it, but whether or not they would welcome any greater discipline as established by the Federal Government in these range of contacts. I am not sure.

Mr. NELSON. Mr. Andrews?

Mr. ANDREWS. No questions, Mr. Chairman.

Mr. NELSON. All right. Let me just conclude this.

Does staff have any questions?

[No response.]

Mr. NELSON. Is that the call of the House? Would you all check to find out if the House has just gone in session?

You basically said earlier that it's because the Soviets are saying that SDI has them so agitated that they are intimating that they are reluctant to have any kind of formal arrangement with regard to cooperation in space? Is that the essence of what you said?

Mr. HORNER. No, I think at this point, to put the proposition more generally, I think they are more interested in seeing what

can be produced from this propaganda onslaught against not merely SDI, but other aspects of the U.S. space program, to see what benefit can be made of it. One realizes, of course, it may create a certain difficulty for them.

All of this precedes the strategic defense initiative, I might say. It's been a recurrent feature of Soviet commentary on the space shuttle, for example, since the time of its inception, that it is basically a militaristic undertaking. And to the degree that they feel that the legitimacy or the receptivity to that kind of propaganda barrage will be undermined by seeming too close collaboration with us, I'm sure they might be concerned by it.

Mr. NELSON. OK. Answer this as a final question. If we go into another space cooperative agreement with the Soviets, we ought to have some clear goals that we want to achieve by that. Would you give us your ideas as to what those ought to be?

Mr. HORNER. Well, first of all, I think the single most important thing we ought to do in assessing the prospects for space cooperation with the Soviet Union is to understand the relation between it and other international space activities that we undertake. We are about to undertake what is, I think, the largest international collaborative science project in the history of the world, which is the space station, which involves substantial international participation, we assume, which involves close and intimate relations with the European space countries and with Japan and with Canada and probably to some other degree with other countries who may become interested in it as time goes on.

I think we ought to remember that it is that kind of activity with friends and allies and associates with whom one can work in a normal—if I may use that word—in a normal way that ought to be the focus of our activities, and we ought to be sure that the main thrust of our space program is not somehow put off balance by really an artificial inflation of the possibilities of real and tangible benefits of cooperation with the Soviet Union, and one ought not to deny that those are there.

But it is a curious thing to me, just as a nonexpert in these matters, that an extraordinary amount of attention is paid to what might be done with the Soviets and, in fact, surprisingly little is paid especially in the political world to what can be done and what is already being done with our friends and allies. That, it seems to me, ought to be the major thrust of what we do.

Now, it may well be the case—and here once again we will have to defer to people who know more about these things than we, in the Department of State, know—that there are areas of excellence in the Soviet Union, that there are institutions of excellence, and there are individuals of great achievement, and that it would be in our interests to draw them into cooperative relations with us for plausible, tangible reasons. And I think that's the kind of thing that ought to be thought out.

I think that if we approach cooperation with the Russians in space with only diffuse political atmospheric objectives in mind, if we approach it only with the sense that in some vague and general way we might improve something called "the climate," although we don't exactly know how, I think then we will open ourselves up

to a certain number of practical difficulties and in the end it will become self-defeating.

Mr. NELSON. I am curious as to why you get the impression that we haven't had a lot of international contacts with regard to our space program. Why do you say that?

Mr. HORNER. Excuse me?

Mr. NELSON. You said earlier that you think the emphasis ought to be, instead of with the Soviets, that the emphasis ought to be on other international partners.

Mr. HORNER. No, no. My point was that there is an enormous amount of international cooperation underway with them and even more contemplated through the space station program and elsewhere, and my only suggestion was that it's important that we keep the priorities in proper order and to recognize what's more important to our space program and what's less important—that's all.

Mr. NELSON. As a matter of fact, we have quite a few international contacts going on. You don't have to be a part of NASA to understand that. We have had a little bit of a reverse reaction here on this committee, being concerned about are we having so much international participation that there might be a technology transfer starting to occur.

But again, space offers the unique environment for coming together with international partners, and that has dramatically been illustrated just with the space transportation system, and the participation of Canada, with the arm. Now, we have the memoranda of understanding that have been signed with regard to the space station by ESA as well as Canada and Japan, and the fact that several astronauts that are citizens of other countries have now flown with our astronauts and participated in the missions. So it's a unique environment, and I think NASA has approached it quite well.

Well, Mr. Horner, thank you. We appreciate your being here today.

Now could I ask Deke and Vance to come on up?

As I said earlier, Gen. Tom Stafford is unable to be with us today, and his testimony is submitted and made a part of the record.

We are just delighted to have the two of you with us. Is there any particular order that we should go in with the two of you?

Mr. BRAND. I think we should let Deke go first.

Mr. NELSON. What does that do? Is that deferring to seniority? [Laughter.]

Mr. SLAYTON. "Maturity," I think, is the right word, not "seniority."

Mr. NELSON. All right. Please proceed.

STATEMENT OF DONALD K. SLAYTON, SPACE SERVICES, INC., OF AMERICA

Mr. SLAYTON. Yes, sir. I gathered at the onset that you did not wish us to read a prepared statement, so I will just try to summarize what is in that.

Mr. Chairman, and members of the committee, it really is a pleasure to be here with you this morning. I think the essence of what I had to say is that I started out being probably one of the most anti-Russian people you could find in this country. I spent a whole lot of time in the Air Force, so that was my prime career motivation, and a lot more in NASA, where my prime job was to compete with them directly head on. So when we went into the Apollo-Soyuz program, it was a bit of a cultural shock for me, probably more so than most people.

But we did discover in the process of working with them for 3 years, getting to know them on a personal basis, that they aren't all that different from the people in this country. On a personal basis, they are almost identical. They have got the same drives, the same interests, in terms of what they want out of life, what they want for their families that the people in this country do.

I don't think that they are at all interested in getting into a conflict with us directly. They've had enough of that in their recent history, much moreso than we have in this country, and they really understand it. They don't want it again.

So it's my opinion that anything that we can do of a constructive nature—recognizing what Secretary Horner said, that it's not all roses. But my experience has been if you're working with people on something constructive, that you aren't too likely to be fighting with them at the same time. And for what little you can gain, it's certainly well worth the effort of trying to make it happen.

So I am a strong proponent of having a follow-on program of some kind. We can talk more about what that should be later. But I think it's one of those things that just should be done, and we ought to expend every effort to make it happen.

[The prepared statement of Mr. Slayton follows:]

Statement of Donald K. (Deke) Slayton

President, Space Services Inc. of America (SSI)

Before the Subcommittee on Space Science and Applications

Chairman Nelson, members of the Subcomittee, it is a pleasure to have the opportunity of appearing before you today. You wished me to express my thoughts on the original ASTP flight 10 years ago and the possibility of future joint space endeavors between the U.S. and U.S.S.R..

As a crew member who had been involved in heated competition with the Russians since the start of the space race, my initial reactions to discussions of a joint mission in the early '70's were not positive. In fact, I'd been trained to view the Russians as something less than friendly competitors for at least 15 years prior to Sputnik. However, almost 30 years of prejudicial thinking evaporated rapidly with the realization that the ASTP might be my first and only chance to get into space. (For those who don't remember, I was pulled off the 2nd orbital Mercury flight for a minor medical problem and spent the next 10 years fighting to get back on flight status.)

The selfish motiviation of finally getting a chance at a space flight performed wonders in improving my attitude towards the Russians. I had met a few Cosmonauts in social situations earlier and concluded our interests and personalities were not that divergent. We just marched to different drummers.

Upon being assigned to the ASTP flight, our extensive joint training exercises both in the U.S. and the U.S.S.R., convinced me that the Russians were more to be pitied than feared. We were given the most hospitable treatment you can imagine. The Cosmonauts, their families, and associates are genuinely warm, friendly and generous people -- the kind of folks you cannot not like on a personal basis. These characteristics were generally consistent in other elements of the population we met throughout the U.S.S.R..

However, in dealing with them on an official or professional basis there is an underlying sense of suspicion or mistrust. This characteristic did not seem reserved for us but existed to some extent in their relationships with each other, so I was not personally upset by it. It's also worth noting that we eventually created a great amount of trust between us which still exists today. This may be the greatest legacy of ASTP.

I'm not about to pose as an expert in the national behavior of any country, but believe there is one aspect of Russian background that is not adequately understood or appreciated

by most people in this country. WWII, called the Great Patriotic War in Russia, created unbelievable devastation on the population and economy. Our Civil War was the last and only war fought by this country with anything close to that experience, and then only on a small scale. People outside our armed forces, and in fact a reasonable percentage of those in, have not experienced war and have little comprehension about what it's all about. The same can be said about the younger elements of the Soviet population, but there are still plenty who do remember and they aren't about to let anyone else forget, as a visit to Volgograd or Leningrad will confirm. In my opinion, that experience still exerts a strong influence on their personal and official relationships. They do not want a repeat performance, and instinctively view all outsiders with a certain element of suspicion.

I believe this experience works to our advantage. If we can build on the good relations established during ASTP towards a new constructive goal or preferably series of goals in joint space ventures, an automatic by-product is an increasing level of trust and decreasing level of international tension. Is it too wild to speculate that from this other joint ventures might evolve, which if carried to the extreme might result in everyone on this planet using their resources for constructive instead of destructive purposes? Probably. But I believe the citizens of the U.S.S.R. and U.S. would opt for that choice if given a chance. Almost anything worth doing gets done a step at a time. ASTP was a first major step. Senator Matsunaga's concept of an International Space Year is another. Interim joint activities between our space shuttle and the Salyut space station are doable anytime someone wishes to schedule them. A mid-term goal of lunar bases and/or Mars landing is another achievable step, and beyond that we have the stars.

Space activities by themselves are not going to solve all the world's problems. However, I believe space operations are viewed by most nations as a prestigous, highly visible and peaceful activity. They can act as the beacon or catalyst for many other activities. ASTP performed this function very well in its time, and it is no one's fault that we lacked the vehicle to follow up for a number of years. Both we and and the U.S.S.R. now have the capability to perform steady state space operations, and I believe joint activities would be helpful to all.

DONALD K. SLAYTON

BIRTHPLACE & DATE: Sparta, Wisconsin on March 1, 1924

PHYSICAL DESCRIPTION: Gray hair; blue eyes; 5'10 1/2"; 165 lbs.

MARITAL STATUS: 1983, Married to the former Bobbie Osborn of Dickinson, Texas

CHILDREN: Kent, April 8, 1957

EDUCATION: Graduated from Sparta High School in Sparta, Wisconsin; Bachelor of Science degree in Aeronautical Engineering from the University of Minnesota, Minneapolis, Minnesota in 1949; honorary doctorate in Science from Carthage College, Carthage, Illinois in 1961; honorary degree in Engineering from Michigan Technological University in Houghton, Michigan in 1965.

RECREATIONAL INTERESTS: Hunting, fishing, shooting, airplane racing

ORGANIZATIONS: Fellow of the Society of Experimental Test Pilots, the American Astronautical Society, and the American Institute of Aeronautics and Astronautics; member of the Experimental Aircraft Association, the Space Pioneers, the International Formula Pylon Air Racers, and the National Air Racing Group; life member of the Order of Daedalians, the National Rifle Association of America, the Veterans of Foreign Wars, and the Fraternal Order of Eagles; and honorary member of the American Fighter Aces Association, and the National WWII Glider Pilots Association.

SPECIAL HONORS: Awarded four NASA Distinguished Service Medals, two NASA Outstanding Leadership Medals, and a NASA Exceptional Service Medad; the Collier Trophy; the SETP Iven C. Kincheloe Award; the General Billy Mitchell Award; the SETP J. H. Doolittle Award for 1972; the National Institute of Social Science's Gold Medal in 1976; the Zeta Beta Tau's Award Richard Gottheil Medal in 1975; the Wright Brothers International Manned Space Flight Award in 1975; the Veterans of Foreign Wars National Space Award in 1976; the Federation Aeronautique Internationale's Yuri Gargarian Gold Medal in 1976; the American Heart Association's Heart of the Year Award in 1976; the University of Minnesota's Outstanding Achievement Award in 1977; the Houston Area Federal Business Association's Civil Servant of the Year Award in 1977; the AAS Flight Achievement Award for 1978.

DONALD K. SLAYTON

MILITARY EXPERIENCE: Entered the Air Force in April 1942 as an aviation cadet and received wings in April 1943 after completing flight training at Vernon and Waco, Texas. Flew 56 combat missions in Europe as a B-25 pilot with the 340th Bombardment Group. Returned to the United Stated in mid-1944 and served as a B-25 and A-26 instructor pilot at Columbia, South Carolina. In April 1945, was sent to Okinawa with the 319th Bombardment Group and flew 7 combat missions over Japan in A-26s. Served as a B-25 instructor for one year following the end of the war and left the Air Force to enter the University of Minnesota. Became an aeronautical engineer after graduation and worked for 2 years with the Boeing Aircraft Corporation at Seattle, Washington, before being recalled to active duty in 1951 with the Minnesota Air National Guard.

Assigned as maintenance flight test officer of an F-51 squadron located in Minneapolis, followed by 18 months as a technical inspector at Headquarters Twelfth Air Force, Weisbaden, Germany, and a similar tour as fighter pilot and maintenance officer with the 36th Fighter Day Wing at Bitburg, Germany. Returning to the United States in May 1955, attended the USAF Test Pilot School at Edwards Air Force Base, California. Was an experimental fighter test pinot there until April 1959 conducting flight tests of fighter aircraft built for the United States and some foreign countries.

Logged more than 8,000 hours flying time, including 5,000 hours in jet aircraft.

NASA EXPERIENCE: Named as one of the Mercury astronauts in April 1959. Originally scheduled to pilot the Mercury-Atlas missions but was relieved of this assignment due to a heart anomoly discovered in August 1959. The MA-7 mission was subsequently flown by M. Scott Carpenter in May 1962.

Became the first Chief, Astronaut Office in September 1962 and was responsible for the management of the astronaut office. In November 1963, resigned commission as an Air Force Major to assume the role of Director of Flight Crew Operations. In this capacity, was responsible for directing the activities of the astronaut office, the aircraft operations office, the flight crew integration division, the crew training and simulation division, and the crew procedures division. Was restored to full flight status in March 1972, following a comprehensive review of medical status by NASA's Director of Life Sciences and the Federal Aviation Agency.

Apollo Docking Module Pilot of the Apollo-Soyuz Test Project (ASTP) mission, July 15-24, 1975 -- a joint space flight culminating in the first historical meeting in space between American astronauts and Soviet cosmonauts. Completing the United States flight crew for this 9-day earth-orbital mission were Thomas P. Stafford and Vance D. Brand. In the Soviet spacecraft were cosmonauts Alexey Leonov and Valery Kubasov.

The crewmen of both nations participated in a rendezvous and subsequent docking, with Apollo the active spacecraft. The event marked the successful testing of a universal docking system and signaled a major advance in efforts to pave the way for the conduct of joint experiments and/or the exchange of mutual assistance in future international space explorations. There were 44 hours of docked joint activities during ASTP, highlighted by four crew transfers and the completion of a number of joint scientific experiments and engineering investigations. All major ASTP objectives were accomplished and included: testing a compatible rendevous systems in orbit; testing of androgynous docking assemblies; verifying techniques for crew transfers; and gaining experience in the conduct of joint international flights. Apollo splashed down in the Pacific Ocean near Hawaii and was quickly recovered by the USS New Orleans. Slayton logged 217 hours and 28 minutes in his first space flight.

As Manager of the Space Shuttle Approach and Landing Test from December 1975 through November 1977, Slayton directed the Space Shuttle through a series of critical Orbiter Flight Tests that allowed inflight test and checkout of flight controls and Orbiter subsystems and permitted extensive evaluations of the Orbiter's subsonic flying qualities and performance characteristics. These tests also verified capability to ferry Shuttle aboard the 747 which was used as launch vehicle.

From November 1977, until retiring March 1982, he served as Manager for Orbital Flight Test, directing orbital flight mission preparations and conducting missions operations. This included OFT operations scheduling, mission configuration control, preflight stack configuration control, conducting planning reviews, mission readiness reviews, and postflight mission evaluations.

CIVILIAN EXPERIENCE: Mission Director and Range Safety Officer for the successful private venture launch of the Conestoga 1, September 9, 1982 from Matagorda, Island. Consultant to Aerospace Corporation. Elected President of Space Services in November 1982.

CURRENT ACTIVITIES: President and Vice Chairman, Space Services Incorporated of America; Chairman, Space America Incorporated; President, International Formula One Pylon Air Races; Member, Department of Transportation Commercial Space Advisory Committee; Consultant, Aerospace Corporations; Director, Columbia Astronautics.

STATEMENT OF VANCE D. BRAND, LYNDON B. JOHNSON SPACE CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. BRAND. Well, thank you for the opportunity to be here this morning. I will go ahead and read my statement and then would be happy to answer any questions if I can.

Apollo-Soyuz was a technical success. 1975 appeared to be an international relations success. The mission was a technical success because the space program of two nations' programs were coordinated together effectively to perform a complicated linkup in space. The technical work included coordination of the mission control centers and the joint design ground test and use of a unique docking system which served as an adapter between the Apollo and the Soyuz spacecraft.

Working relations between the personnel of both countries involved in the joint mission were very good. Personnel on both sides had the common goal of creating mission success and any political differences between the two countries were, by and large, not discussed.

Although at the time it appeared that Apollo-Soyuz was an important step forward in international relations, later events indicate that the mission's effect may have been superficial. Apollo-Soyuz dramatized detente and probably was the most visible feature of detente. The hopes that were held for continued improvement in Soviet-American relations were not realized, in my opinion.

What we gained from Apollo-Soyuz was a better understanding of what makes the Soviets tick, knowledge of the state of their space technology in 1975, and an estimate of their future capabilities.

In addition, the program put us into direct communication with a large number of Soviets either directly or indirectly through the communications media.

In short, we opened a small crack in the Iron Curtain for a time.

It was not a technological harvest for us, but it served to keep our space team intact in between the skylab and the space shuttle programs; 28 scientific experiments were successfully completed during the 9-day flight, and 5 of these were joint experiments with the Soviets.

What did the Soviets gain from us? They adopted some of our astronaut training methods, I think. They were exposed to our management techniques and engineering creativity at close range, and learned something about how we think.

For example, the Soviets trained their cosmonauts, trained them for spacewalks now, in water tanks after having observed this to be an effective method at the Marshall Space Flight Center in the early 1970's. In recent years, the Soviets have spent much effort on inflight repair of their spacecraft. Salyut-7 currently is being repaired and activated after equipment failures on orbit. The vigor and creativity of their activities is reminiscent of our inflight repairs conducted on the skylab space station and the shuttle, space shuttle. It is questionable whether they can apply many of our management techniques in their system. Certainly, they have been exposed to our management structure, and can apply our tech-

niques in areas such as quality control, reliability, design for systems redundancy, and planning for emergencies.

I do not know just how much of our Apollo spacecraft and spacesuit technology was adopted by the Soviets. In 1975 we were not very concerned, because the Apollo technology was old technology in our eyes and soon was to be replaced with newer space shuttle technology.

Finally, the joint mission allowed the Soviets to become identified with the highly successful Apollo Program, thereby appearing to the world and to their people to be on a par with Apollo. This public relations coup probably did not hurt us, but certainly gained them something.

In summary, Apollo-Soyuz demonstrated that a joint space mission cannot in itself eliminate war and create a new climate of peace in international understanding. There needs to be a sufficient underlying climate of good feeling between the United States and the Soviet Union if a joint mission is to significantly accelerate cooperative activities and benefits.

There may be space projects in the future that are so huge or ambitious that they can only be justified and accomplished through international cooperation. The manned Mars landing probably falls in this category. For this reason, the world should be moving in the direction of increasing international space cooperation where it is needed.

Mr. Chairman, that concludes my statement. I would be happy to answer any questions.

[The prepared statement of Mr. Brand follows:]

NASA
National Aeronautics and Space Administration

Hold for Release Until
Presented by Witness

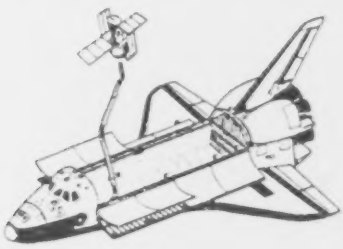
July 31, 1985

Subcommittee on Space Science and Applications
Committee on Science and Technology

House of Representatives

Statement by:

Vance D. Brand
Civilian Astronaut
Johnson Space Center



99th Congress

Statement of

Mr. Vance D. Brand
Civilian Astronaut

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the
Subcommittee on Space Science and Applications
Committee on Science and Technology
House of Representatives

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to appear before the Subcommittee to present my reflections on the Apollo-Soyuz mission.

Apollo-Soyuz was a technical success, and in 1975 appeared to be an international relations success. The mission was a technical success because the space programs of two nations were coordinated together effectively to perform a complicated linkup in space. The technical work included coordination of the mission control centers and the joint design, ground test and use of a unique new docking system which served as an adapter between the Apollo and Soyuz spacecraft. Working relations between the personnel of both countries involved in the joint mission were very good. Personnel on both sides had the common goal of creating mission success, and any political differences between the two countries were, by in large, not discussed. Although, at the time, it appeared that Apollo-Soyuz was an important step forward in international relations, later events indicate that the mission's effect may have been superficial. Apollo-Soyuz dramatized detente and probably was the most visible feature of detente. The hopes that were held for continued improvement in Soviet/American relations were not realized in my opinion.

What we gained from Apollo-Soyuz was a better understanding of what makes the Soviets tick, knowledge of the state of their space technology in 1975, and an estimate of their future capabilities. In addition, the program put us into direct communication with a large number of Soviets either directly or indirectly through the communications media. In short, we opened a small crack in the iron curtain for a time. It was not a technological harvest for us, but it served to keep our space team intact in between the Skylab and the Space Shuttle programs. Twenty-eight scientific experiments were successfully completed during the nine day flight.

What did the Soviets gain from us? They adopted some of our astronaut training methods, were exposed to our management techniques and engineering creativity at close range, and learned something about how we think. For example, the Soviets train their cosmonauts for space walks now in water tanks after having observed this to be an effective method at the Marshall Space Flight Center in the early 1970's. In recent years, the Soviets have spent much effort on in-flight repair of their spacecraft. Salyut 7 currently is being repaired and activated after equipment failures on orbit. The vigor and creativity of their activities is reminiscent of our in-flight repairs conducted on the Skylab Space Station and on the Space Shuttle. It is questionable whether they can apply many of our management techniques in their system. Certainly they have been exposed to our management structure and can apply our techniques in areas such as quality control, reliability, design for systems redundancy, and planning for emergencies.

I do not know just how much of our Apollo spacecraft and space suit technology was adopted by the Soviets. In 1975 we were not very concerned, because the Apollo technology was old technology in our eyes, and was soon to be replaced with newer Space Shuttle technology.

Finally, the joint mission allowed the Soviets to become identified with the highly successful Apollo program thereby appearing to the world and to their people to be on par with Apollo. This public relations coup probably did not hurt us, but certainly gained them something.

In summary, Apollo-Soyuz demonstrated that a joint space mission cannot in itself eliminate war and create a new climate of peace and international understanding. There needs to be a sufficient underlying climate of good feeling between the United States and the Soviet Union, if a joint mission is to significantly accelerate cooperative activities and benefits.

There may be space projects of the future that are so huge or ambitious that they can only be justified and accomplished through international cooperation. The manned Mars landing probably falls in this category. For this reason, the world should be moving in the direction of increasing international space cooperation where it is needed.

Mr. Chairman this concludes my statement and I would be pleased to answer any questions the Subcommittee may have.

52-457 O—85——4

Mr. NELSON. OK. Thank you.

A couple of weeks ago, when we had the reception here in this room for you all and the two cosmonauts, I was struck by what a warmth was exuded. It was obvious that you all were friends, and it was obvious that you had a great deal of affection for each other, and it was obvious that a lot of the Americans who had worked on the program that had come back to that reception for the little reunion had obvious affection for the two Soviet cosmonauts. So what you have described in the human dimensions was there.

Did we get, other than the personal observations of you all into their lives as human beings, as members of the human race, did you have an insight that was valuable and was relayed to our policymakers here about the Soviet society and what makes them tick? Did you relay that, or was it more that it was just a sort of personal interaction between you that was conveyed to the world because of the technological success of the mission?

Mr. SLAYTON. I think it was probably some of both, Mr. Chairman. I think one thing that we understood about them in the process of that program—at least I didn't know; maybe a lot of other people did—is that they do have an innate suspicion of not only us but amongst themselves. And there is very little lateral communciation, which was surprising, because they would send a team over to our country in preparation for a training exercise over there, we would pass on a whole lot of detailed data and get to Moscow's Star City to start training, and suddenly discover that information had not been transmitted to the right people.

They have a very difficult time communicating. It's a combination, I think, of suspicion and maybe a certain amount of power that goes with knowing something nobody else knows, I am not sure which. But we were constantly—at least I was—surprised by this lack of cross-fertilization.

When we were trying to learn about some of their systems, for example, we discovered that there might be one guy that knew something about it that nobody else did, and in many cases this gentleman couldn't bring himself to tell us about it either because we were on the wrong side. And we had to play some hardball with them once in a while to get that kind of information.

But I have always felt that if there was one thing we could have gained out of this whole program, it would have been this—they would have learned how to manage a big program the way we do because if they ever got to that point, what they've then done is become a democracy. And that would have been worth the price of the whole program.

Mr. NELSON. Indeed. As a matter of fact, I remember yesterday in the testimony—and I can't remember who it was, but I think it was Mr. Beggs that said that—he used specifically General Stafford's name—said that he would run up against closed doors and that he would continue to knock on the door until it finally opened as far as having that communication with whatever it was, the particular subject matter. He relayed to us that this happened time and time again, but he (Stafford) was absolutely insistent as the commander of the crew that that information be shared.

In Tom's absence, can you all share with us any of those specific instances?

Mr. BRAND. Well, I think that any time that you are negotiating and dealing with another country, getting ready for a mission, that you have to deal in a lot of specifics and you have to have joint analyses and things like that, and it ends up that there is just a lot of opportunity to have disagreement.

I think, with the Russians, Tom had a very good way of dealing with them. I think he could be firm with a smile on his face, and that in many instances did pay off. There were examples of compromise; for example, where we thought we'd have a real hard time with them—some of this was a little bit before I got into the program—but they did have to bring their cabin atmosphere down to about 14 to 7 psi so that we could strike a compromise and have a good design for our docking module as an airlock. And I think people were surprised at how easy that compromise went.

Mr. NELSON. And you're not saying it was a technological compromise, it was more a political compromise?

Mr. BRAND. It was a technological compromise, but it required effort and study and resources spent on their part.

Mr. SLAYTON. I think a good example also was a trip to their launch site. Nobody had ever been to their launch facility so far as we knew except Charles DeGaulle, and they were not prone to let us go down there either. This is one where Tom and our program management decided, "Hey, we really need to go look at that spacecraft the same as we do ours at the launch facility." We insisted on that, and they finally gave in.

There again, they didn't give in totally. They flew us in there at night and flew us out at night, and showed us what they wanted to show us during the daytime. But we saw what we had to see.

But I think it was made very clear to us that they had what they viewed as national programs which were none of our business and they didn't intend to talk to us about, and then the international, or the Salyut, program, Soyuz program. They did talk to us some about Salyut, which they didn't really need to. But they had that very clear differentiation in their mind as to what we were allowed to view and be involved in and what we weren't.

But I think, in general, if it was involved with the flight and what was necessary to do it, we always got it sooner or later.

Mr. NELSON. By the way, has any American part of the Government been back to the launch site since you all were there?

Mr. BRAND. We probably wouldn't know for sure, but I haven't heard of an American being back there.

Mr. NELSON. And this is what is referred to as the Cosmodrome?

Mr. BRAND. Yes. Baikonur in Central Asia. Some people call it Tyriatam. I think there's a railhead there at Tyriatam.

Mr. NELSON. So you were able to get there to see the specific spacecraft that was going to fly?

Mr. SLAYTON. Yes.

Mr. NELSON. And to see the launch system and basically eyeball it to see what you were going to be linking up with? Go ahead.

Mr. BRAND. Yes, well, we had really a requirement to do that because as you know, we had transfers between the spacecraft, and once we got into their spacecraft we had to know that our cameras would plug in over there correctly once we were in flight and so forth. So we had a good reason on the ground to go in with our

cameras and one thing and another and check out how they worked on their side.

Mr. NELSON. How many times did they visit the Kennedy Space Center prior to the flight?

Mr. BRAND. One that I remember.

Mr. SLAYTON. I think it was only once that I remember, yes.

Mr. NELSON. And did you all do the similar thing at Johnson or at Kennedy for them getting into our spacecraft, into our Apollo spacecraft? Was that done in a mockup out at Johnson?

Mr. BRAND. Well, they trained in a mockup of their spacecraft and ours together at the Johnson Space Center.

Mr. NELSON. I see.

Mr. BRAND. And at Star City, near Moscow, why, we trained a little bit in their Soyuz simulator.

Mr. NELSON. Did we have trouble trying to find out enough about the design of their spacecraft in order to build a mockup so that you could train?

Mr. SLAYTON. No, I think generally not. We did have some problems with some of their subsystems managers. They're not used to their crews being involved in a nature like we are. We treat everybody as a test pilot basically, and the crews get heavily involved in the design and development of the system. Cosmonauts don't do that. They kind of come in after it's designed and built, and somebody says, "Hey, this is the way you operate it. You do this, and leave everything else alone." They don't really get into the level of understanding.

So when we started training with them, of course, we're used to understanding systems in great detail, and we wanted to get that level of detail. And their subsystems engineers who knew in many cases could not bring themselves to give it to us. But we eventually would work it through the cosmonauts in some cases.

Mr. BRAND. I think everything was handled from their side very much on a need-to-know basis.

Mr. SLAYTON. Yes.

Mr. BRAND. And sometimes our definition of "need-to-know" is different from theirs. In general, I thought that there was a good exchange.

I remember one interesting incident, though. We spent some time in Star City learning about Soyuz, and one morning we were to learn about how their gyro system works, and I think we spent most of a morning trying to understand whether they had a gyro platform or a rate gyro system, and we had a very intelligent instructor, a Soviet who had helped to design the system. We came out that morning not knowing whether they had a rate gyro-based system or a platform.

So there were times when I wasn't quite sure if we'd been fooled or if—you know, we just had a different reference frame. We just couldn't get together an understanding.

Mr. NELSON. Did you have backup staff with you over there? Was it basically just the three of you exchanging information, or did you have a lot of NASA personnel with you that were working the whole thing, too?

Mr. SLAYTON. There was a number of NASA personnel. We had subsystem managers assigned to every subsystem that worked di-

rectly with the Russian counterparts. We had our crew training personnel involved with us. Of course, we had interpreters along with us.

Mr. NELSON. And they accompanied you over there to the Soviet launch site?

Mr. SLAYTON. Yes.

Mr. BRAND. Right.

Mr. NELSON. I remember reading a comment that I think was attributable to George Low after the flight, and it was something to the effect that since each side protected its own technology, that the value of the exchange was in understanding each other's system and operating systems, and since ours was an open society, that was readily available anyway. So that was the real value to us, that we got an insight into the Soviet space program and the way they operate that otherwise we would not have had, and that this comment, I think, by Mr. Low was that in that regard then we profited the most from that particular mission.

Do you want to make any comments as to whether or not that's true or to expand?

Mr. SLAYTON. I think George expressed it very well. I think that's precisely right.

Mr. NELSON. I see.

Mr. BRAND. I think he did, too, and I think it's hard to evaluate—impossible to evaluate—who profited the most, because just understanding the system and the foot-in-the-door, seeing into the Iron Curtain, as I said, was a big thing with us.

We had one thing that made it easier for us, too. We didn't worry so much about technology transfer because we were throwing that spacecraft away after the mission, and had they had all the plans, it would have taken them 7 or 8 years to build an Apollo module, which would have been way out of date.

Mr. NELSON. Ms. Meyers?

Ms. MEYERS. I am sorry I am late, Mr. Chairman. Maybe you have asked this question.

But I would like to ask if you think that we should re-enact the United States-Soviet space cooperation agreement? In other words, from what I have heard since I came in, there were some positive things that came out of this association.

Mr. BRAND. Well, I can't tread in areas that are probably Mr. Beggs's responsibility. As a citizen, my personal opinion is that I think it would probably be good.

Ms. MEYERS. But do you think there was enough beneficial that was gained so that it's good to pursue this kind of cooperation? I guess that is what I am asking?

Mr. BRAND. My personal opinion is, yes, you have to be very unemotional and you have to think very hard after you do that, what are the best areas for exchange, where we get mutual benefit.

Mr. SLAYTON. Yes, I am a firm believer in continuing the joint operations. I tend to extrapolate a little bit beyond the near term. You know, we had a session here when the Soviets were here a couple of weeks ago related to Mars exploration, a whole day of it.

I think if you want to extrapolate into that timeframe, you know, past the shuttle, past the space station, where we're talking new, ambitious programs that are going to be very expensive and are

going to take a lot of resources, that it would make a lot of sense to have not only a joint United States-Soviet program but maybe a world-type program, and for precisely the reasons we're talking about it being good to have United States-Soviet relationships: if you get everybody on this world all working toward the same thing, doing something constructive, I can't think of a better driving force to try to keep it pulled together and united. To me, that's the big benefit of it.

Since it's going to be expensive in resources, why not have everybody share and throw some in the kitty and we'll all be working together?

So whether you do that through the treaty of 1982 extension or some other mechanism, that's not for us to say, but I think from a philosophical point of view, that it's certainly well worth the effort.

Mr. BRAND. A good example of a place where we have fairly equal capability and a real need to get together, I think, is some of the unmanned planetary missions in the near term. You know, they can use our big antennas to get data back. They know a lot about how to put spacecraft on and around Venus. That's a place where, scientifically, there is probably a fairly equal base on either side.

Ms. MEYERS. Thank you.

Mr. NELSON. I just want to compliment you all for taking a stand. There are too many people running around this city that wouldn't answer that question that Ms. Meyers put to you. One of the things that's wrong with late 20th century America and the world is that too many people dodge, duck, obfuscate, including the U.S. State Department, as represented here earlier.

I want to compliment you for taking this stand, and I want you to know that I feel the same way as you, that it's time to move out, for us to renew that agreement and explore every possibility of cooperation, recognizing that we're dealing with an adversary, and that sometimes when you shake hands, you've got to count all your fingers to make sure that you still have them.

Recognizing that, space is the one unique environment in which, given the state of tension between our two countries, that in fact you can forge cooperative ventures, both manned and unmanned. It's just time, in my judgment, to move out.

Now, to the credit of the President, he made that initiative several months ago with regard to a simulated rescue mission. That has not been reciprocated by the Soviets. And I think it's time for them to get off their duff and start moving.

Of course, politics is such that, you know, everybody postures and does its rhetoric and the propaganda and so forth, and that's the world we live in whether you're dealing with space or international boundaries or armies facing each other or whatever side you happen to be on, on a Federal budget, trying to negotiate your position.

So I just want to compliment you.

Now let's go on from there and talk about the follow-on program that you made some reference to. You talked, Vance, about the fact that we might look at an unmanned kind of mission, which is in the near term. Are you looking really to—is it feasible from your perspective as astronauts, is it feasible for us to look into the far

term and start to talk seriously about what's being talked generally about a manned mission, a joint mission where we would share resources, a manned mission to Mars?

Mr. BRAND. I think we can talk about it. The question is, I guess, where do we go? We know that any joint mission to Mars is either going to have to wait for 50 or 60 years until the time when it's very cheap and easy for us to do. It would practically be like falling off a log. Or else if we do it sooner, we may have to have a world effort to do it to justify it and fund it.

So it has to start somewhere, and it certainly wouldn't be in the next 5 or 10 years. I certainly think it's worth talking about.

Mr. SLAYTON. Well, just to follow up on that, our experience has been that any major program is going to take us at least 10 years from the time you decide you want to do it, and probably longer than that from the idea stage. So I certainly don't think it's any too early to be talking about it.

I wouldn't propose that it's going to happen before the end of the century, but that's only 15 years away. And it's certainly within the state of the art to pursue a program like that at this time. So I don't think it's inconceivable to set a goal to have a Mars manned landing by the year 2000 in a joint mission. And if you want to do that, then you are certainly going to have to start working it fairly soon, certainly not tomorrow, but you can't wait too long.

Mr. NELSON. Any of the staff have any questions?

[No response.]

Mr. NELSON. May I digress, Vance, and would you mind bringing us up to date from your perspective about the present mission, what you know? Yesterday we took advantage of Mr. Beggs' appearance and had him give us an update as to the specifics of the sensor and so forth on the cutoff of No. 1 engine.

An overview from you would be most appreciated.

Mr. BRAND. OK. I haven't been in contact with Houston this morning, having been on travel. But as you know, there seems to be, it's my understanding, more fingerpointing at the sensors than the actual operation of the engine. It looks like perhaps two sensors failed when we had a good engine running, and due to the sensor failure, shut down a good engine.

Of course, that means, I guess, that somebody will be thinking about improving the sensors.

Mr. NELSON. Indeed, he said that was underway, Mr. Beggs did.

Mr. BRAND. Yes. And we are in a lower than planned orbit, but a very safe orbit, and an orbit where a large part of the science will be recovered, but not quite all.

Mr. NELSON. Now, what is it about the lower orbit that does not allow the tracking instrument to perform as you would want it to at the optimum?

Mr. BRAND. I am really not the guy to be answering that. But I think the tracking problem might be independent of the orbit altitude.

Mr. NELSON. I see.

Mr. BRAND. The main thing about being in a lower orbit is you have a few atoms of one kind or another—oxygen, nitrogen, helium and so forth—that are still bouncing around up there in the lower orbit that can interfere with the scan of the instruments.

Mr. NELSON. OK. Any further questions?

[No response.]

Mr. NELSON. Well, thank you all. You honor us with your presence. We are delighted to see you, and thanks again for that tremendous reception that we had here. It was a good time of old friends coming together again, and it was a good day's activities that you all participated in that day.

We will see if we're going to have the opportunity to recreate those festivities over there in the Soviet Union. We will see if that's forthcoming.

Mr. SLAYTON. Great. Thank you.

Mr. BRAND. Thank you for inviting us.

Mr. NELSON. Have a good day.

All right, may I ask our panel of scientists, Dr. Simpson, Dr. Smith, Dr. Masursky, and Dr. Klein, if you all would please come up to the table.

We welcome you.

[Pause.]

Mr. NELSON. Well, it is a pleasure to have you gentlemen here. Your reputation has certainly preceded you. For these 2 days of hearings your testimony is most valuable to us. Is there any particular order that you gentlemen would like to proceed, or shall we do it just in the order that you have been listed on the agenda? Is that all right with you all?

All right, then, Dr. Simpson. Again, let me invite you that rather than reading your prepared statement, if you want to just share it with us conversationally, you are welcome to do so. It's at your pleasure.

STATEMENTS OF DR. JOHN SIMPSON, UNIVERSITY OF CHICAGO, LABORATORY OF ASTROPHYSICS AND SPACE RESEARCH; DR. BRADFORD SMITH, DEPARTMENT OF PLANETARY SCIENCES, UNIVERSITY OF ARIZONA; DR. HAROLD MASURSKY, SENIOR SCIENTIST, U.S. GEOLOGICAL SURVEY; AND DR. HAROLD P. KLEIN

Dr. SIMPSON. Thank you, Mr. Chairman. I appreciate the invitation which you and the members of the subcommittee have given to me to express my views on Soviet-United States relations in a period when we have the expiration of the United States-Soviet space cooperative agreement.

I think that my remarks are a summary of what I have submitted to you. In those remarks you will find that in each position I have taken I have documented it with referencing and evidence so that you can follow it up as to the justification for the positions I take.

Now, what we are really talking about today is the period, an interim period, where we do not have an official agreement, and a period where our present relationships are at a rather low level politically, and the question really is, what should we be doing now and what should we be doing over the immediate years leading to the time when we can look forward to an agreement?

So my remarks are focused really on the first steps from today on, taking advantage of what we have learned up to this moment

and what we can look forward to. And so I decided that since I have had a long-term interest in this subject, and as a matter of fact I was one of the 12 organizers of the International Geophysical Year and in the particular discipline of cosmic physics and the application of satellites, I then as early as 1954 or 1953 was very much involved with the Soviets on the way they behave in an international framework during the cold war.

So that experience, plus the experience which I will recite to you today of a real-time association I have now, in which I have with the University of Chicago an experiment on two Soviet space probes going to Halley's Comet, I would like to tell you a little bit about that experience and to point out that the framework of that experience can provide for us a plan of how we might move ahead in a very simple, very constructive way that will benefit the United States scientifically and in many ways in terms of extending our understanding of the Soviet positions at the present time.

Now, it's often argued—so I take these two, the legacies of the IGY and my current enterprise, Now, it's been argued again and again that we can do little to reach understandings with the Soviets and cooperation such as space as long as our political relationships and confidence in each other continue at a low level. The IGY, I think, is the best refutation of that.

In my working with them, we had the following situation. The IGY picked up speed in 1953, with most of the nations joining in the effort recognizing the value to them and also recognizing that it provided a forum for their scientists and engineers to take part in worldwide enterprise.

For the Soviets, however, they held out. I remember very well the meeting in Rome in 1954 for the IGY. The Soviets were interested enough to come to their offices in Naples and sit back and wait and hear what was going on up in Rome. Every night we would send them a message about how much success we were having in the IGY. At the end of the third day, while some of us were talking in the forum in Rome, a side door opened, and three gentlemen in gray coats walked in and joined the IGY. It was more to their benefit to join than to stay out.

Now, the consequence of that in the IGY, of course, was that they contributed heavily to areas that were vital to all of our interests; namely, the oceans, under the oceans, and, in particular, participants in the Antarctic agreement.

So my key message here is that we shouldn't be deterred by the overall political scene in our efforts to establish cooperative agreements in space, whether official or unofficial.

Now, in the spirit of time, the shortening time, I will try to very briefly summarize the second example, which I claim is now being played in real time.

The device that I invented that attracted their attention so much was in the spring of 1983, just a little over 24 months ago. It was a device that provided a new way to measure cosmic dust. It can measure in ways that provided reliable results over a vast range, as I will mention in a moment.

I was so excited about this, and others were, that I went over to Europe and gave a talk in Western Europe. This was the fall of 1983. Already we had proved the principles within 4 months.

However, the Europeans were already so far downstream in terms of their engineering and design of the Giotto mission, there was no way they could incorporate an extra little experiment onboard, much as they were interested in it.

However, they had connections with Moscow, since there was joint cooperation between them in various ways between the two Soviet missions to Halley's Comet and the European. And when the news got to Academician Sagdeev, director of the Space Research Institute in Moscow, he then arranged, and I received in October a telegram saying, "We accept your experiments for Halley's Comet. How soon can you be in Moscow?"

Well, essentially, this was a challenge that's not lightly dismissed at a time of these times, especially since the United States had no Halley's Comet mission and probably would not have a suitable mission for experiments of the type that I was describing until about 1991 or even later.

Mr. NELSON. So that contact was made through the Europeans, specifically ESA?

Mr. SIMPSON. Through the Europeans, through some scientists in the audience who were traveling back and forth who already turned out to be the Germans, who had a joint experiment already, had been working 4 years on the Halley Comet mission.

So this established the beginning. And my approach was to say, "Look, maybe this is a way to not only achieve our scientific objectives"—in a new area for me, because I am mostly in cosmic ray physics—"but also why don't we try to see if this can't be a test case of how to really do things so that we benefit and they benefit?"

If we can make this a good test case in an environment which is not just U.S.-U.S.S.R. relationships, a murky situation in our own Government about what we should do and what we shouldn't be doing and why we shouldn't transfer technology and all of that, I decided, well, let's see what we can do.

The net result was, without going into details, that my first move was to look at what the rules were, what the laws were, and discovered that they were pretty tight. You can't transfer technology without approval. Well, that's fine.

So what I ordered my staff to do was while I am busy sorting this thing out, back design one generation, let's use anything, even back to vacuum tubes if we had to. No technology involved. We can do the same thing. We can make the same measurements. We can do it in many, many different ways. So let's not push the system in terms of technology transfer, let's just do it with things that are on the open market.

Well, without going into details, I did have the approval of all agencies of our Government to do this. I got it within about 73 days. And of course, one of the keys was essentially this myth, so to speak, of technology transfer in these areas. And we did it by simply having all the parts being available in the United States commercially, Japan, West Germany, and England—take your choice. And we showed this to the DOD and the State Department, and more or less just said, "Well, OK, that's not a problem for us." OK.

Mr. NELSON. Did you, Dr. Simpson, actually have to downgrade your experiment so that it would pass that litmus test of technology transfer?

Mr. SIMPSON. Yes. I decided to apply the litmus test in advance, assuming that this was the way it's going to go.

Mr. NELSON. I see.

Mr. SIMPSON. I refused to put a microprocessor in. That would have saved me tremendously. But why put it in? Why push the system when it's what I consider to be a nonissue, and just go ourselves?

The net result was that we almost pushed ourselves so far back we couldn't find the materials still on the market. But we succeeded.

In any case, I then got in touch with the Soviets and said, "Look, I am ready to talk." And so we met in February of 1984 in Budapest. They sent a team, one team science, the other team engineering. While we met, and met for 10 days to discuss how we would put an experiment on a spacecraft where it only is finished but already the other experiments have been delivered and launch it 10 months later, it was a real dicey situation.

So they realized the speed with which you had to work, and they set up in Moscow a standby group of scientists and engineers to answer questions from Budapest on an on-call basis. I won't go into the details.

So we sat down with our third party. We had to work through the third party. In this case it was the Max Planck Institute of West Germany. They were at one end of the able, the Soviets on the one side, my team was on the other. We sat down and said, "Look, you guys want it, we want it."

Here I will tell you why they need it, and later we need it because we want the science, we want to demonstrate you can do these things.

We worked very hard. At night I would sit in my hotel room with a drafting board and a little hand calculator and work through the changes in what came up that day. One day we came in, and there was a very glum look on the faces of my Soviet colleagues. He said, "The message from Moscow is the engineers say they absolutely will not change the spacecraft. It's already on its way to testing. No way." It sounded familiar.

So we argued about it, and they said, "Give us another day." They came in the next day all smiles and said, "We report back"—he was the scientist one—"we're going to change the spacecraft."

So we went on to finish the design. The agreement was that they would forward to Chicago their hardware, their computer that interfaced and read out the signals as they are on their spacecraft, their command system. They would give me all the interface control documents of the VEGA spacecraft for science, the mission materials that I needed, the characteristics of the Proton-1 rocket vibration characteristics that I insisted on shaking the gear in Chicago and not in Moscow.

All of this arrived by KLM flight in a big box one day a month later. This was followed by our demand that they send a Soviet engineer to Chicago for a month to teach us all about it. They did.

I then was able to walk into the Space Research Institute on May 7 with our first working unit and have my engineers supervise the installation on their spacecraft.

They let us right into the spacecraft facility. We worked there day after day, worked with their software people. And I won't go into the details. Some of it's in the prepared testimony.

But the two spacecrafts then carrying our experiments were run through tests in their facilities, transported to Baikonur in September, launched December 15 and December 21, 1984, within 4 hours after the first launch we received a telephone call in Chicago verifying that their launch was successful and that our experiment was working.

Ever since that time, they have provided—we have provided magnetic tapes to them, blank. They fill them up and send them back to us. Our data look great. The latest data I have is 2 weeks old. The whole thing works. All through this time at Chicago we established what I can only call a "cool line" between Moscow and Chicago. It was used for developing the engineering, keeping in touch with the mission. This continues to work. It's never been broken. The agreements have not been broken.

Now, essentially, the key is they benefit from having onboard an instrument of high sensitivity and vast dynamic range which can continue to function under destructive dust conditions through the survivability range of their spacecraft.

All the instruments they had on their spacecraft for these measurements would have gone into saturation, and if the spacecraft had died while everything was in saturation, they would have no idea where to put the second spacecraft 3 days later. It's vital for them.

We benefit from the opportunity to make the first measurements of the mass distribution of dust from the plume of a coment. We can use this. Not only is it scientifically important, but we can use the results of this in our design for a U.S. cometary program in the 1990's.

So it's a real working, what I call hands-on frame of reference for doing things, and this is what I claim is the way to go for unmanned missions that help the United States and help the Soviets.

You will find in the written testimony a complete list of how international the Vega mission was. All the experiments are listed with the principal investigators. You will see that in spite of the political situation, they list the University of Chicago and myself as the principal investigator on the Vega mission for this experiment.

This created considerable criticism among some people in the Soviet Union, as reported by the Soviets working with us, but they essentially surmounted these counter difficulties, just as we would have difficulties in the States.

Mr. NELSON. I missed that. Why? Was there criticism in the Soviet Union?

Dr. SIMPSON. Some of them believed that they shouldn't be carrying a U.S. experiment at the time.

Mr. NELSON. Oh, I see. I see. Who funded the experiment?

Dr. SIMPSON. There are lots of other Soviet experiments that could have been plugged in.

Mr. NELSON. I see. Dr. Simpson, did the University of Chicago fund you?

Dr. SIMPSON. No, fortunately, before I started this thing, I talked to the head of the planetary program at NASA and said, "Would you consider funding this if I succeed in going through this massive net, where it looked horribly complicated?" I don't know whether he agreed that he would do his best to help us because he didn't feel that I ever could handle this in a matter of a few months or whether he was just hopeful that it would work.

But in any case, it worked, and in January they came in with the letter from Mr. Lawrence Eagleburger, telling me to go ahead, with certain constraints. And so they came up very generously and helped me. And it has been a very important cooperation between NASA and the U.S.S.R.—between NASA and the University of Chicago.

Now, I would like to close my remarks by saying that all of this leads to my suggestions or a set of recommendations which I would like to see Congress embody in whatever it plans to do in the months ahead.

I think, first of all, that for the immediate future, while we're trying to find our way through all of this, that we should try to keep what I call low-level but hands-on type of experiments going.

You raised a very interesting point, Mr. Chairman. Whatever funds NASA was able to come up with, obviously had to come at great expense from some other effort that they had planned. I mean, it wasn't in the plan. I have learned subsequently that really NASA can't divert funds for these what you might call missions of opportunity and at the same time be fair to our own science community for a program that's already fully loaded under a very tight budget.

One of my recommendations, therefore, that you will find in this is that we should request that Congress put a new line item into the NASA budget which would provide something on the order of $5 to $10 million a year that would enable specific experiments that meet the criteria that I have described in that memorandum to go between the U.S. and the U.S.S.R. that is very much to our interest. It would be funds very well spent. It would open, and keep open, other doors that would be quite beneficial to us.

Now, what are some of those other constraints? One is that the technology transfer is a question. There is no question regarding the need to prevent the flow of technological information which has already been classified as vital to our own interests and national security. But the technology that we're talking about transferring is technology that can be variously handled at different levels in terms of the way we execute an experiment. And our own scientists and engineers are clever guys. I mean, we know how to get around the problems of something that's so sensitive that we shouldn't be putting it on a spacecraft. So I consider that technology transfer, within the framework of what we're talking, as a nonissue.

So my feeling is that the cooperation in unmanned specific enterprises in space with the U.S.S.R. at this time is merely an extension of our policy of cooperation with the Western nations. In that frame of reference, I think we should be moving out.

Now, I have one last point I would like to make. That is, any policies regarding cooperation with the U.S.S.R. in space science and exploration must be tested constantly against a fundamental principle that the openness in science on a worldwide scale is vital both of the vitality of scientific progress and the strength of democratic nations. With these caveats, cooperation as well as healthy competition with the Soviets can only add to the stature of our Nation. As a leading spacefaring Nation, we cannot do less if we intend to be a leader in space in the 21st century.

I want to thank you for the opportunity to express these views.

[The prepared statement of Dr. Simpson follows:]

Statement of

John A. Simpson
Professor of Physics
University of Chicago

Before the

Subcommittee on Space Science and Applications
Committee on Science and Technology
U.S. House of Representatives

July 31, 1985

Mr. Chairman and Members of the Subcommittee:

I appreciate the invitation of your Subcommittee to present my views on the vital subject, as stated in your invitation, of "whether meaningful scientific cooperation and exchange can and should be encouraged despite the expiration of the U.S.-Soviet (civilian) space cooperation agreement in 1982". In these chambers of Congress over the past two years or more we have heard arguments presented on the potential gains and drawbacks for the United States of any scientific cooperative effort with the Soviets. These discussions came to focus with the signing by President Reagan of Public Law #98-562 on 30 October 1984 - which represented a consensus of the views of Congress that every effort should be made to reestablish a bilateral agreement for joint civilian efforts in space between the U.S. and the U.S.S.R.

The execution of an official agreement depends on the resolution of many factors which leave us, for the interim, in a period of uncertainty regarding current U.S. policy towards immediate opportunities for low levels of cooperation in unmanned civilian space activities between the two sides.

In this interim period we have two clear alternatives - namely:

1) The position that the several existing or pending opportunities and/or invitations for unofficial cooperation by the U.S.S.R. should remain "tabled" until they can be brought under an official bilateral agreement, whenever that occurs in the future. This appears to be a widely held view in our government at the present time. There are some sound administrative and budgetary arguments for this view.

2) The opposite position is that we now have some meaningful cooperative efforts ongoing between the U.S. scientists and the U.S.S.R. scientists which are beneficial to U.S. science and, at the same time, keep open the doors for contact between the two societies and provide opportunities for future exploratory discussions.

It is this latter position which I argue for here today as being in the best interest not only of the U.S. space sciences, but in the best interest of our nation.

Much in the interim debates during these past years is based on positions taken by individuals who rely on the beliefs, assumptions, or biases of those who are remote from the real world of science and engineering. Perhaps I can cut through this murky situation with some specific examples in support of my position and the recommendations I would like later to offer your Subcommittee. In view of the short time available for discussion, I shall draw upon two specific examples of which I have intimate knowledge, through specific participation, that bear on the answers regarding the value of cooperation and may defuse such contentious issues as transfer of sensitive technologies.

My first example is historical - namely, the International Geophysical Year in 1957-1958 (IGY); the other example is current, or "real time" - namely, cooperation between the University of Chicago and the Space Research Institute of Moscow concerning two spacecraft missions to encounters with Halley's Comet in March 1986. In conclusion, I will suggest a set of criteria which I believe has all of the essential elements for strengthening further the U.S. position in the space sciences and exploration - while, at the same time, it keeps open the doors of unofficial cooperation with the Soviets, thereby providing a baseline of information necessary for working out a more effective official bilateral agreement.

THE LEGACIES OF THE INTERNATIONAL GEOPHYSICAL YEAR

It has often been argued that we can do little in reaching understandings with the Soviets in scientific cooperation as long as our political relationships and confidence in each other continue at such a low level. However, one of the most significant international collaborations among nations in the entire history of our civilization--which included the cooperation of the U.S.S.R.--occurred in the years of the Cold War.

I was fortunate to be one of the scientists organizing the International Geophysical Year. To direct 67 participating nations, 12 scientists were responsible, each for a specific scientific and exploratory discipline.[1] My area was cosmic physics with applications which extended to the use of vehicles to outer space, such as satellites. Although most nations had joined the IGY by 1953, the U.S.S.R. held out against joining until our meetings in Rome in 1954, finally being convinced that they would benefit more from joining than holding out. Subsequently they contributed in many major areas of science. For example, especially surprising was their competence in oceanography and exploration of the seas and Antarctica. They are joint signatories to an Antarctica agreement for the peaceful study of our last continent to be explored. This part of their contribution was overshadowed largely by the launch of Sputnik soon after the start of the IGY.

Both the U.S. and the U.S.S.R. had declared intentions to launch satellites during the IGY. I have to dispute the widely held view that the U.S. did not know of the Soviet's plans to launch in 1957 - especially since I and another U.S. scientist were given specific information on the proposed orbit frequency of transmission and other details in Barcelona in 1956. We informed U.S. agencies of these facts on our return, but to no avail. (We now know that the U.S. could have been first into space were it not for internal U.S. policy decisions - but that is another story involving further evidence of lack of firm science and technology policy at that time.) During the Cold War both the U.S. and the U.S.S.R.

learned a great deal about each other as a result of the IGY. Historically we may never fully assess the value of the political legacy of the IGY, but on balance it clearly was positive.[2]

My key message here is that we should not be deterred by the overall political scene in our efforts to establish cooperative scientific enterprises in space, whether official or unofficial.

ON TO HALLEY'S COMET WITH U.S. PARTICIPATION

My second example, which is being played in real time, began with my invention in the Spring of 1983 of a new way to detect extremely small dust particles of cometary or interstellar origin.[3] Decisive measurements which proved the device could be of special value for comet encounters came in August 1983, when the Max Planck Institute (Heidelburg) made available to us their dust accelerator (the United States does not have an equivalent facility). By September it was clear to me that it would be ideal for an encounter with Halley's Comet, and I gave a lecture in the European Space Agency to those concerned with the Giotto spacecraft being built for this purpose. Alas, it was too late to be considered for inclusion in the ESA's Giotto Misison, but when--unknown to me--the news of the device reached Academician Sagdeev (Director, Space Research Institute, Moscow) I subsequently received an invitation in October 1983 offering to put my experiments (not yet designed) on the Soviet's two spacecrafts to Halley's Comet (Vega-1 and Vega-2). They were spacecrafts which were already built and were already receiving experiments from many countries for launch in 15 months. Clearly, since the University of Chicago is a private institution, it was easier to approach me unofficially, working through a third party. This was a challenge not lightly dismissed, especially since the U.S. had no Halley's Comet mission and probably would not have a suitable mission for an instrument of this type until 1991, or later. On the other hand, I was determined that such an enterprise must meet with the approval of our government agencies, while simultaneously serving as a test for how to cooperate through a direct "hands-on" effort such that both the U.S. and the U.S.S.R. would reap solid benefits from the effort.

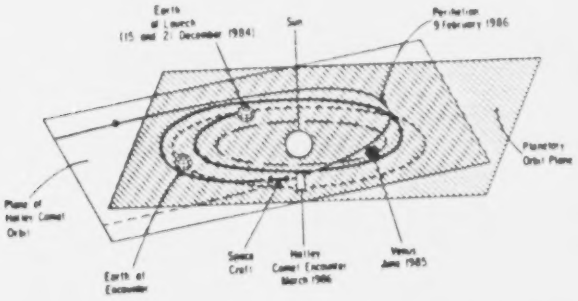
I solved the problem of technology transfer to the satisfaction of all concerned by designing the experiment using only components and designs which could be obtained readily - not only in the open market in the U.S. as "old tech", but also in England, West Germany, and Japan.[4] Thus, we were able to create a new concept for dust detection to advance our scientific investigations on a unique mission without the transfer of new technology. Furthermore, I insisted that the entire instrument be constructed, sealed and made flightworthy in my laboratory prior to delivery. Finally, with no official bilateral agreement in place, we established our contacts through the good auspices of the Max Planck Institute, Lindau (West Germany). With these provisos, we received approval to proceed on 3 January 1984.

In February 1984 my staff and I sat down with our Soviet counterparts, hosted by the Max Planck Institute, Lindau, at a meeting in the Central Research Institute in Hungary. Each side (U.S. and U.S.S.R.) knew why they wanted the experiment and we came to firm agreements on how to interface a new instrument on a completely finished spacecraft to be launched only 10 months later. Since I had no knowledge of the Soviet engineering interfaces (electronics, mechanical, thermal, data,

computer, etc.), I had to insist on this information being given to me immediately. On their side they agreed to ship to the University of Chicago their computer/spacecraft interface hardware, their interface engineering documents and other documents regarding spacecraft design and operation. They agreed to send an engineer to explain it all to us. The Max Planck staff's advice was vital to us since they had been working on their experiment on these missions for over four years. We established what I might call a "cool line" between the University of Chicago and Moscow so we could quickly get answers to our designing problems.

We began an around-the-clock effort on 5 March with members of my engineering and technical staff who had built 30 of my previous experiments for missions in space. On 7 May I walked into the Space Research Institute, Moscow, and was able to have my engineer supervise putting our first unit on their spacecraft. It all worked. I think it is fair to say that the Soviet scientists and engineers were astonished that we could carry out this effort, especially on a foreign spacecraft, in only 12-15 weeks - so were we!

While in Moscow we worked with their computer software staff to incorporate our data outputs so that we had a computer format familiar to us in Chicago. After the delivery of three additional instruments with tests in Moscow, the two spacecraft were transported to the Baikonur Cosmodrome in September. The launches were on 15 December and 21 December, 1984. Within four hours after the successful launch of the first spacecraft, the Russians reached us in Chicago by telephone to verify that their launch was successful and our instrument was working OK - as they had agreed to do.



The above figure shows the trajectories of the comet and the two Vega spacecraft, which we have translated from reports to us from the Space Research Institute, Moscow.[4] Our agreement is that we give them blank magnetic tapes which they fill periodically with our science and engineering data from their telemetry network. The tapes are brought back by various persons visiting their Research Institute. The data are excellent and the instruments on both spacecrafts are, as of this time, performing as expected. By agreement, my staff and I will receive my data in Moscow and/or Budapest within 24 hours of each encounter. This will enable our results to be made available to assist both with the second Vega and the Giotto spacecrafts in determining how close to come to the comet head without

being destroyed by the hypervelocity impacting dust. We will publish promptly all our results and conclusions, along with the two Russian scientists who are Co-investigators with us. This is what I define as "hands-on" participation in a spacecraft mission.

So far as I know, this is the first time the Soviets have delivered flight-related hardware to scientists in the United States (via Hungary and West Germany).

They benefit by having on board an instrument of high sensitivity and vast dynamic range which should continue to function under destructive dust conditions through the survivability range of their spacecraft. We benefit from the opportunity to make the first measurements of the mass distribution of dust from the coma of a major comet - results which will be of vital importance to the U.S. program of cometary encounters in the 1990's.

Several Western nations--principally France, West Germany and Austria--have contributed instrumentation to the Vega scientific payload, along with nations in the Soviet sphere, to make this an international mission. The following table, translated from a Russian volume[5] describing the missions in detail, includes the University of Chicago experiment (DYCMA) with myself as Principal Investigator.

Acronym	Experiment	Mass (kg)	Power (W)	Direct TM (b/s)	Recorded TM (b/20 min)	Collaborating Institutes (Principal Investigators)
TVs	Television	32	50	32768	-	LAS, Marseille, F (F. Cruvellier) Central Research Institute for Physics, Budapest, Hun (L. Szabo) IKI, Moscow, USSR (G. Avanesov)
IKS	Infrared Spectrometer	16	18	4096	4320	Observatoire de Meudon, F (A. Coustenis) IKI, Moscow, USSR
TKS	Three-channel spectrometer	14	30	12288	-	Observatoire de Besancon, F (G. Moreels) IKI, Moscow, USSR (V. Kreenopolsky) Bulgaria (A. Gogoshev)
PRORAB	Grunt penetration detector	2	4	100	-	USSR
DYCMA	Dust particle detector	3	2	100	100	University of Chicago, USA (J. Simpson) MPI, Lindau, FRG / IKI, Moscow, USSR Central Research Institute for Physics, Budapest, Hun
SP-2	Dust particle detector	4	4	1024	2160	IKI, Leningrad, USSR (E. Nazarova)
SP-1	Dust particle detector	2	1	150	2160	IKI, Moscow, USSR (O. Vaisberg)
PUMA	Dust mass spectrometer	19	31	10240	-	MPI, Heidelberg, FRG, (J. Kissel) Service d'Aeronomie, Verrieres, F (J.-G. Bertaux) IKI, Moscow, USSR (R. Sagdeev)
DID	Neutral gas mass spectrometer	7	8	1024	1080	MPI, Lindau, FRG (E. Keppler) Service d'Aeronomie, Verrieres, F IKI, Moscow, USSR / University of Arizona, USA
PR-1	Plasma energy analyser	9	8	2048	15120	IKI, Moscow, USSR (K. Grinyaev) Central Research Institute for Physics, Budapest, Hun MPI, Lindau, FRG/SRD-ESA, ESTEC, NL
TE-M	Energetic particle analyser	5	6	512	648	Central Research Institute for Physics, Budapest, Hun (A. Somogyi) IKI, Moscow, USSR / MPI, Lindau, FRG Nuclear Research Institute, Moscow, USSR
MISCHA	Magnetometer	4	6	512	2160	Space Research Institute, Graz, Austria (W. Riedler) IZMIRAN, Troitsk, USSR
APV-M	Wave and plasma analyser	5	8	2048	2808	IKI,Moscow, USSR, (S. Klimov) / Poland (I. Kravtsyk) Tchecoslovaquie (J. Vojta)
APV-V	Wave and plasma analyser	3	2	512	1512	SRD-ESA, ESTEC, NL (R. Grard) / LPCE, Orleans, F IZMIRAN, Troitsk, USSR

The Soviets have been surprisingly open in encouraging international participation in their Halley Comet missions. Clearly, scientific knowledge will be gained which could not be obtained by the participating individual nations alone.

The insights gained from these personal experiences lead me to suggest a specific interim strategy for the United States at this time, again as I emphasize, pending the highly desirable bilateral agreement which could simplify activities for all concerned parties.

There is an increasing number of U.S.S.R. unmanned missions in space science and exploration where U.S. scientists, as well as scientists from other nations, have been asked to participate. We should exploit selectively those experiment opportunities under a set of guidelines which will not only enhance U.S. space science and contribute to the confidence building between our two societies, but also will lay the groundwork for the future - especially for an official bilateral agreement.

In my opinion, the following are prudent, specific steps to take:

1) All experimental missions are to be hands-on in the spirit of our comet mission instrument enterprise described above;

2) Since there can be no question regarding the need to prevent the flow of technological information which has already been classified as vital for national security, the technology to be used in the instruments and the modes for their use are to be those which are already known widely in the world of science and engineering. Scientists and engineers know how to use various established technologies to accomplish their measurement objectives in space (technology transfer is a non-issue);

3) The experiments in a cooperative effort should be complimentary to the broad scientific goals set forth for U.S. space science by NASA and the Space Science Board of the National Academy of Sciences;

4) The value of the cooperation must not only be evident for the U.S., but must also, from the point of view of the Soviets, be clearly to their own benefit;

5) NASA should be encouraged to support these efforts. It is well understood at present that NASA does not have the funds for this purpose, since any funds used for this objective are funds which must be taken from an already tight budget directed to U.S. scientists having ongoing programs;

6) To alleviate "5" above, it is recommended that for the next year or so Congress be asked to introduce a line item to fund cooperative hands-on efforts by providing an estimated 5-10 million dollars per year. I believe such a sum would be adequate for a meaningful program covering several scientific disciplines;

7) For each experiment each side must have continued access to the data, and agreements must include prompt publication in scientific journals of scientific results, instrument description, etc., accessible in both the East and the West.

The technical strength of our country is viewed by many nations in terms of our accomplishments in space, science and exploration. They are the most visible.

We already have acknowleged our limitations in what exploration and science can be accomplished with U.S. funds alone by the establishment of many collaborations with ESA and other Western nations. Cooperation in unmanned, scientific enterprises in space with the U.S.S.R. at this time is merely an extension of this policy.

Hopefully, there will come a day when, under official bilateral agreements, the U.S. will be able to invite Soviet scientists to build some of their best experiments as contributions to the U.S. civilian space missions. This would be a significant step in building confidence.

We must strive to reduce to a minimum the use of space science for political objectives, instead of the Soviet approach where science is often the pawn of political policy.

Any policies regarding cooperation with the U.S.S.R. in space science and exploration must be tested constantly against the fundamental principle that openness in science on a world-wide scale is vital to both the vitality of scientific progress and the strength of democratic nations. With these caveats, cooperation--as well as healthy competition--with the Soviets can only add to the stature of our nation. As a leading spacefaring nation we cannot do less if we intend to be a leader in space in the twenty first century.

References

1. IGY: Year of Discovery, S. Chapman (The University of Michigan Press), 1959. See page 102 on organization of the scientific branches of the IGY.

2. The Political Legacy of the International Geophysical Year, Harold Bullis, Prepared for the Subcommittee of the Committee on Foreign Affairs (U.S. House of Representatives), 1973, U.S. Government Printing Office, Washington, D.C. 20402.

3. Polarized Polymer Films as Electronic Pulse Detectors of Cosmic Dust Particles. J.A. Simpson and A.J. Tuzzolino, Nuclear Instruments and Methods in Physics Research, Vol. A236, pages 187-202, 1985.

4. A Cometary and Interplanetary Dust Experiment on the Vega Spacecraft Mission to Halley's Comet, M.A. Perkins, J.A. Simpson and A.J. Tuzzolino, Nuclear Instruments and Methods in Physics Research (in press, 1985).

5. From "Scientific and Technical Description of The Venus Halley Project", with preface by R.Z. Sagdeev (Imprimerie Louis-Jean, 05502, CAP, France November 1984.
   See also: "Space Missions to Halley's Comet and The Inter-agency Consultative Group", European Space Agency Publication, ESA-SP1066, 1985.

Brief Curriculum Vitae

JOHN ALEXANDER SIMPSON
1119 East 53rd Street
Chicago, Illinois 60615

Birthdate: November 3, 1916
Portland, Oregon

A.B.	1940, Reed College
M.S.	1942, New York University
Ph.D.	1943, New York University (University Heights)
D.Sc.	1981, Reed College (Honorary)

Present Position:

ARTHUR H. COMPTON DISTINGUISHED SERVICE PROFESSOR OF PHYSICS, Enrico Fermi Institute, Department of Physics and the College, The University of Chicago

Some Former Positions

1943-46	SCIENTIFIC GROUP LEADER, Metallurgical Laboratory (A-Bomb Manhattan Project)
1973-78	DIRECTOR, Enrico Fermi Institute, The University of Chicago

Honorary:

Elected National Academy of Sciences (1959)
Phi Beta Kappa
Society of Sigma Xi
Fellow, American Academy of Arts and Sciences
Fellow, John Simon Guggenheim Fellow (1972)
Visiting Associate in Physics, California Inst. of Technology
Visiting Scholar, University of California, Berkeley
NASA Medal for Exceptional Scientific Achievement
Quantrell Award for Excellence in Undergraduate Teaching (1980)
Fellow, John Simon Guggenheim Fellow (1984-85)
Visiting Scientist, Cambridge University, England (1984)
Visiting Scholar, University of California, San Diego (1985)
Nora and Edward Ryerson Lecturer (1985-86)

J.A. Simpson

NATIONAL:

Fellow, American Physical Society
Fellow, American Geophysical Union
Fellow, Center for Policy Study
Member, American Astronomical Society
Member, U.S. National Committee for the International Geophysical Year
Member, Space Science Board, National Academy of Sciences (1958-67) Consultant (1967-71)
Member, U.S. Technical Panel for Cosmic Rays
Chairman, Atomic Scientists of Chicago (1945-46)
Member, Astronomy Missions Board, NASA (1968-70)
Established (1964) Laboratory for Astrophysics and Space Research in the Enrico Fermi Institute, University of Chicago
Chairman, Division of Cosmic Physics, American Physical Society (1970-71)
Board of Overseers, Visiting Committee in Astronomy, Harvard University (1970-71)
Member, President's Science Advisor, Advisory Group on Science Programs (1975-76)
Trustee, Adler Planetarium (1977-)
Member, Board of Directors, Bulletin of Atomic Scientists (1982-)

INTERNATIONAL:

Member, International Academy of Astronautics
Member of the CSAGI (Special Committee to organize the International Geophysical Year) (1954-60)
President, International Commission on Cosmic Radiation (I.U.P.A.P.) (1964-67)

CURRENT RESEARCH AREAS:

Origin of cosmic rays and composition of the radiation; magnetic fields and charged particles in interplanetary space; solar flare particle acceleration and propagation; solar-terrestrial physics; magnetospheric particle acceleration. The isotopic and chemical composition of solar flare accelerated nuclei and the cosmic radiation. Cosmic and cometary dust experiments. High energy astrophysics experiments in space with Earth satellites and deep space, and planetary probes to Mercury, Venus, Mars, Jupiter and Saturn. Probes to Halley's Comet. Experiments on the Ulysses Mission (launch 1986) over the poles of the solar system.

Mr. NELSON. Thank you, Dr. Simpson.

Tell me, where is the Space Research Institute?

Dr. SIMPSON. The central—the space institute is centered in Moscow. Structurally, it's part of the U.S.S.R. Academy of Sciences. The engineering facilities are right within the inner heart of this giant building. And, more or less, there are three levels of security. There is an outer bound where you find the workers and the paper shufflers. On the second level, you find engineers and technicians. The inner level is the ongoing actual preparation of missions, including the testing and everything, and the chiefs of the mission.

It's the inner region that we were allowed to work, inside the third level of security.

Mr. NELSON. You mentioned your previous participation in IGY. Do you think there is any value in what Senator Matsunaga in the Senate has introduced and I have introduced over here which is calling for 1992 to be International Space Year? It also is an anniversary of the IGY and a few other anniversaries, including the 35th of Sputnik and the 500th of Columbus discovering the New World and so forth.

What do you think about all that?

Dr. SIMPSON. Well, first of all, it's all very nice to have all these symbolisms, but let's strip away all the symbolisms and say that if we were starting where Columbus hadn't discovered America in 1492, but let's look at it from the point of view of what's in our interests as a world. I would say that it's a very imaginative idea.

If we go back and ask the question about what the IGY did for the various nations of the world, it's fantastic. I think the gentleman to my left will confirm that from the IGY we learned more about the Earth and the Earth's environment and the problems we face in the environment than man has learned in all of history preceding, and all of this within an 18-month format. It was fantastic.

But also, there was a political legacy to all of this. The nations learned to work together, and the politicians were sort of admiring how we were able to get things done in a climate where there was a cold war going on. It's quite an achievement, really, for a group to sit down and work out an Antarctica agreement to exploit our last continent without trying to get one-upmanship on the arrangement.

Also, if you look in the agreement, we were very lucky to be able to get the Soviets and others, since we all had to use military resources—you see, it was our navies that did this. I think our Navy was surprised by what came out in participation from the Soviets in terms of their Navy, their icebreakers, their capabilities to sound the ocean bottom. All that was new, and it all came out during the IGY.

I think I was also surprised that we were able to negotiate, that nobody would bring "great big guns," "south of the 45th parallel" during the IGY. I mean, all of these things were workable.

I think that in the same spirit, that if we could have a space year properly constructed, and I would suggest that it be done by way of having a lead from our National Academy of Sciences working with the Academy of Sciences of the other nations as a starter and the international associations of scientists, then it would very quickly draw NASA into a leading role in our country, would draw

ESA from the European Community, it will focus on many, many things that ultimately spill over into the humanitarian areas.

One, of course, is this rescue thing that's already been going for years. But there are many others. There is the question of the fact that the photographs from space already predicted a year and a half before the present drought that the Ethiopians were going to starve. And I think that we need more of a focus on this on a world scale. There is just too much fragmentation in the world at the present time, and this ISY that Senator Matsunaga and his colleagues propose, I think, is a very imaginative way to proceed.

Mr. NELSON. All right. You have been a most engaging leadoff witness for this panel. We have a recorded vote in progress now, and I am going to recess the hearing, run over there and vote, and come back, and we will proceed.

Dr. Klein, have you got a time problem?

Dr. KLEIN. Yes, I really do.

Mr. NELSON. All right. Why don't we just take you and we can go, and I can dash. We have somewhere around 6 or 5 minutes to go. So let's go with your statement.

Dr. KLEIN. I can read my statement.

Mr. NELSON. I am sorry?

Dr. KLEIN. I can read my statement.

Mr. NELSON. Why don't you share it with us?

Dr. KLEIN. It would probably be the fastest, I think.

Mr. NELSON. All right, whatever is your pleasure.

Dr. KLEIN. I think that I can go through it quickly.

I was Director of Life Sciences at NASA's Ames Research Center in Mountain View, CA. While I was there, I was directly involved in a continuing and varied association with space colleagues from the Soviet Union which began with the first meeting of the U.S.-U.S.S.R. working group in space biology and medicine in Moscow in 1971.

Over the years since then I have remained a member of that working group and participated in official discussions with them approximately once every year either in the United States or in this country.

Under the aegis of this working group I had the opportunity to visit technical installations in Moscow, in Leningrad, and in Tashkent. But more importantly, I came in contact with dozens of space scientists and administrators on that side, and I was afforded the chance to get a firsthand look at their research activities, their operations, and their underlying objectives.

In addition to this, in my role as the Director of Life Sciences at Ames, it became my responsibility to oversee the implementation of all U.S. experiments that were flown on the Soviet Cosmos biological satellites. I will say more about this later. We were also the host to a team of Soviet cardiovascular scientists for several weeks for an important joint study of the effects of weightlessness on cardiac function. Finally, I participated as a principal investigator in 1977 and 1979 on two of the Soviet Cosmos missions.

I believe that the interactions in this area of life sciences between the United States and the Soviet Union over the past 14 years have been extremely beneficial to our programs in these areas. Among the direct tangible benefits, the most important, in

my opinion, has been the open exchange of information concerning manned space flights. At our working group sessions we were presented with detailed data on the effects of flight on the Soviet cosmonauts. We obtained this information months, and even years, before these results became available in technical publications.

Since the Soviet manned program in space has in recent years involved flights of many months' duration during the period when the United States was first preparing for shuttle flights, and then more recently involved in flights of just about a week's duration, we were able to evaluate many of the effects of long-duration space flight on humans by studying the Soviet data.

Their concerns for cardiovascular deconditioning, for bone demineralization, for the effects of radiation, the psychological and other physiological impairments, and for life support systems for such missions surely affected our thinking about long-term human space missions and influenced our own plans and researches into these areas.

The Soviets tried many countermeasures like special exercises, diet, special suits and other devices. They tested these in their manned flights or in their training programs, and the results of their tests were presented to us. I believe that we have been very fortunate to learn from their experiences.

As the United States now contemplates establishing a permanent human presence in space, we can zero in much more effectively on specific biomedical and operational issues because we know better now which measures don't work in actual long-term space flight and which ones hold promise.

Another tangible benefit is also an outgrowth of these working group sessions. In 1974 we were invited to fly on one of the Soviet series of Cosmos unmanned biological satellites. We participated initially in 1975 on Cosmos 782. Similar invitations were subsequently extended to us each time that a Soviet biosatellite mission was planned.

Ultimately, four additional missions were flown, in 1977, 1979, 1983, and most recently, early this month, in July of 1985. By now, a total of 36 U.S. investigations have been flown on these five Cosmos missions; 72 U.S. investigators from 33 different universities and research institutes distributed in 15 States have participated in these missions.

I should emphasize here that during most of this period the U.S. manned program was essentially in a hiatus between the skylab and space shuttle programs, and there were no U.S. unmanned biosatellites. Therefore, the opportunity afforded to us to participate in these Cosmos missions was very important in holding together a portion of the scientific community interested—in the United States—interested in space biology.

Furthermore, the Soviets bore all the launch and operational costs and took care of all the documentation for these missions, and in fact, the actual cost to us in the United States for our experiments was quite low, averaging out at about $50,000 per experiment.

I would like to turn to a few less tangible benefits which, in my opinion, I hold equally important, and I would like to characterize these into two categories.

First, by virtue of working directly with Soviet colleagues, many of our scientists were able to assess the validity, the importance and the direction of some of the research reported to us by the U.S.S.R. For example, because it had been agreed upon that in the Cosmos 936 mission both the United States and the U.S.S.R. would fly comparable radiation dosimeters, each country using its own calibration, its own detection system, it was possible for us to critically evaluate the procedures used by them in these studies.

Moreover, as a result of these interactions, we also learned that the Soviets were actively pursuing other techniques other than simple shielding for protection against space radiation.

We devoted considerable time at several of our working group meetings to the idea of space motion sickness. We discussed relevant research in both countries. We discussed selection and training procedures aimed at reducing the incidence of this disorder. We discussed pharmacological countermeasures. As a result of the concern of both sides, there emerged the idea of holding a joint workshop on this subject at which specialists from both countries could participate. This meeting was held in Moscow in 1980 and brought together United States and Soviet experts to evaluate the state of knowledge on this subject.

Meetings similar to this have also brought together active specialists in cardiovascular physiology and in bone demineralization. There is no doubt in my mind that meetings like this in which scientists meet face to face and are able to ask questions of each other's work are far more effective than trying to evaluate a person's work only through formal publications.

Now I would like to touch briefly upon a second kind of intangible benefit. This has to do with the assimilation of information obtained from diverse discussions with Soviet specialists, often on material that was not yet completed or otherwise not suitable for publication, and then integrating this information into an overall picture of some of the long-range objectives of the Soviet Space Program.

In this regard, had we not participated in the joint working group meetings, I believe we would be largely ignorant of the substantial effort on the part of the U.S.S.R. to study the applicability of artificial gravity devices to future long-duration human missions. Compared to us, they are engaged in a far more ambitious program in this area both in space and in ground-based laboratories.

I have also alluded already to their activity on radiation protection. Let me add one other area that has been relatively obscure in the open literature but which is being very vigorously pursued in the Soviet Union; namely, research on biologically regenerable life support systems for use in long-term space flight.

Mr. NELSON. Dr. Klein, I am down to about 4½ minutes, so I am going to have to dash. Why don't you summarize?

Dr. KLEIN. Yes; in summary, we have profited from these joint activities in a number of ways. Certainly, we could have gone it alone over the past decade and a half in the space life sciences. As we look to the future and ask what is to be gained by further collaborative efforts as to what is to be lost if we do not interact in the future, the major item, in my mind, is the actual biomedical

data to be obtained on a very tiny, but select fraction of the human population; that is, those people who go up into space for extended periods of time.

To to this entirely on our own, we will have to wait another decade or so. In the interim, it is likely that the Soviets will fly many, many missions, many, many people, and that the collection and interpretation of the biomedical data on these individuals will become more and more sophisticated with time. I think it would be extremely useful for us to be involved in, or at least very knowledgeable of, these matters.

Let me leave it at that. I think that these are the main points.

[The prepared statement of Mr. Klein follows:]

Ladies and Gentlemen:

I am pleased to speak to the issue of US-Soviet interactions in Space Biology and Medicine.

While I was Director of Life Sciences at NASA's Ames Research Center, I was directly involved in a continuing, and varied, association with space colleagues in the USSR. This association began with the first meeting, in Moscow, of the US-USSR Working Group in Space Biology and Medicine in October 1971. This Working Group was one of several that had been established earlier that year for space activities between our government and the Soviet Union. Over the years since then, I remained a member of that working group and participated in offical discussions with the Soviets in meetings held approximately once a year either in the USSR or in this country. Under the aegis of this working group, I had the opportunity to visit technical installations in Moscow, Leningrad, and Tashkent. But more importantly, on these visits, I came in contact with dozens of Soviet space scientists and administrators, and was afforded the chance to get first-hand information about their research activities, operations, and underlying objectives.

In addition, in my role as the Director of the Ames Life Sciences organization, it became my responsibility to oversee the implementation of all US experiments that were flown on the USSR Cosmos biosatellites (I will say more about this later) and to host a team of Soviet cardiovascular scientists at Ames for several weeks, for an important joint study of the effects of weightlessness on cardiac function. Finally, I participated - in 1977 and 1979 - as an investigator on two Soviet Cosmos missions.

I believe that the interactions in Space Biology and Medicine between the US and the Soviet Union over the past 14 years have been extremely beneficial to our own programs in these areas. The advantages to us have been both tangible and intangible, and I will attempt here to give you some examples of both kinds of benefits.

Among the direct, tangible, benefits, the most important, in my opinion, has been the open exchange of information, by each side, concerning those manned spaceflights that occurred during the periods between each of our annual working group meetings. At these sessions, we were presented with detailed data on the effects of flight on the Soviet Cosmonauts. Furthermore, we obtained this information months, and even years, before these results became available in technical publications. Since the USSR manned space program has, for many years now, involved flights of many months' duration - during a period when the US was, first, preparing for Shuttle flights and then, more recently, flying missions of only about a week's duration - we were able to evaluate many of the effects of long duration space flight by studying the Soviet data. Their concerns for cardiovascular deconditioning, for bone demineralization, for possible effects of radiation, for psychological and other physiological impairments, and for life support systems for such missions, surely affected our thinking about long-term human space missions, and influenced our own researches into these areas. Many of the potential counter-measures, like special exercises or diets, special suits and other devices, were tested by the Soviets in their manned space flights, or in their training programs, and the results were presented to us. I believe that we have been very fortunate to learn from their experiences. As the US now contemplates establishing a permanent human presence in space, we can "zero in" much more effectively on specific biomedical and operational issues because we know better which measures don't work in actual spaceflight and which ones hold promise.

Another tangible benefit that I would like to discuss briefly was also an outgrowth of our joint Working Group. In 1974, at one of its sessions, we were invited by the Soviets to submit Space Biology proposals for possible flight on one in their series of Cosmos unmanned satellites. We participated, initially, on Cosmos 782, which flew in 1975, carrying a number of US experiments. Similar invitations were extended to us each time that a Soviet biosatellite mission was planned. Ultimately, ~~three~~ four additional missions were flown-in 1977, 1979, ~~and~~ and most recently in July of 1985 1983. By now, a total of 36 US investigations has been flown on these ~~four~~ five Cosmos missions. Seventy two US investigators, from 33 different universities and research institutes, distributed in 15 states, have participated. I should emphasize here that during this period, the US manned program was essentially in a hiatus between the Skylab and Space Shuttle programs. Therefore, the opportunities afforded us to participate in these Cosmos missions were very important in holding together a portion of the community of US scientists interested in Space Biology. Furthermore, since the Soviets bore all the launch and operations costs, and took care of virtually all of the documentation for these missions, the actual cost to the US for our experiments was quite low - averaging out at about fifty thousand dollars each.

Now, turning to the less tangible benefits, which have been, in my opinion, equally important in our past interactions with the Soviet space biologists, I would like to characterize these into two categories. First, by virtue of having to work directly with Soviet colleagues, many of our scientists were able to assess the validity, importance and direction of some of the findings reported to us by the USSR. For example, because it had been agreed that, on the Cosmos 936 mission, both the US and the USSR would fly comparable radiation dosimeters, each country using its own calibration and detection systems, it was possible for Dr. Eugene Benton, of the University of San Francisco in California to critically evaluate the procedures used by his counterpart in these studies, Dr. Eugene Kovalev, of the Institute of Biomedical Problems in Moscow. Moreover, as

a result of these discussions and other interactions between the two groups, we learned that the Soviets were very actively pursuing techniques, other than simple shielding, for protection against space radiation. The opportunity for our specialists to talk with Soviet radiation protection experts, and to evaluate their data, was a direct consequence of the US-USSR Working Group arrangements.

Another example that I would like to cite in this connection, concerns the area of space motion sickness, which has plagued both our astronauts and the Soviet cosmonauts. Since both nations recognized the frequent occurrence of this "sickness", we devoted considerable time at several of the joint Working Group meetings to discussions on relevant research on this in each country; on selection and training procedures for reducing the incidence of this disorder; and on pharmacological countermeasures. As a result of the concern of both sides, there emerged the idea of an in-depth workshop on this subject, at which specialists from both the US and the USSR could participate. This meeting was held in Moscow in 1980, and brought together 8 US, and 12 Soviet experts to critically evaluate the state of knowledge on this subject, and to assess various research concepts for reducing the occurrence of motion sickness symptoms. Meetings, similar to this one, have also brought together active specialists in cardiovascular physiology and bone demineralization, and have resulted in a better understanding of these phenomena as they affect people in space. There is no doubt in my mind that meetings like these, in which scientists meet face-to-face with other specialists in their field, and are able to ask questions of each others' work, are far more effective than trying to evaluate another person's work only through formal publications.

Now, I would like to touch upon a second kind of intangible - but very material - benefit of our long association with the Soviet space biologists. This has to do with assimilating information obtained from diverse presentations by, and discussions with, Soviet specialists - often on material that was not yet completed and, hence, not ready for publication - and integrating this into a fairly reasonable overall

regard, had we not participated in the Space Biology and Medicine Working Group meetings, I believe we would be largely ignorant of a substantial effort on the part of the USSR to study the applicability of artificial gravity devices to future long-duration human missions. Compared to us, they are engaged in far more ambitious programs in this area, both in space and in ground-based laboratories. I have already alluded to their activity in radiation shielding research, which we first learned about through our Working Group activity. To these areas, let me add another one that has been relatively obscure in the open literature, but which, as we learned in our joint meetings, is being pursued very vigorously in the USSR, namely, research on biologically - regenerable life support systems for use in long-term spaceflight.

Taking all of these research objectives, together with their intense and continuing research on the biomedical problems of long-term spaceflight, it is clear that the Soviets have a well-balanced, broad, research program in the life sciences, and that all of this is designed to provide the capability for unlimited human stay-times in space.

In summary, we have profitted from these joint activities in a number of ways. Certainly, we could have gone it alone over the past decade and a half in the space life sciences. As we look to the future and ask what is to be gained by further collaborative efforts, or what is to be lost if we do not work together in the future, the major item is the actual biomedical data obtained on a very tiny and select fraction of the human population: i.e., individuals who go up into space for extended periods of time. To do this entirely on our own, we will have to wait another decade or so. In the interim, it is likely that many people will fly on Soviet missions, and that the collection and interpretation of biomedical data from these individuals will become more and more sophisticated with time. I think it would be extremely useful for us to be involved in, or at least very knowledgeable of, these matters.

In addition, the USSR is already embarked on a series of space missions to study various biomedical issues of human spaceflight, using sub-human primates as surrogates for man. The first of these missions, last year, was quite sophisticated, and we were fortunate to be involved. It is expected that future missions in this series will involve longer and longer durations, thus affording the opportunity to study issues of long-duration flight in great detail. Again, I believe that it would be of great benefit to our programs to participate in such missions.

Finally, let me re-emphasize my opinion that, in the absence of further joint activity, our own researches concerning the care and welfare of people in space, would probably be more diffuse, and somewhat less definitive, and that it would take longer for us to achieve our research objectives because of the inherent paucity of real flight data on our side.

Thank you for this opportunity to present my views.

Biography

HAROLD P. KLEIN

Dr. Harold P. Klein was, until his retirement in June of 1984, Director of Life Sciences at NASA's Ames Research Center, near Mountain View, California, where he was responsible for research and development activities ranging from research on the origin and distribution of life to biomedical research and aviation safety. He is now Scientist-in-residence at the University of Santa Clara in Santa Clara, California.

A specialist in microbial physiology, Dr. Klein went to Ames in 1963 following seven years as professor and chairman of the Biology department at Brandeis University in Massachusetts. He has also taught at the University of California at Berkeley, and at the University of Washington medical school. Dr. Klein has published more than 140 technical papers in the areas of microbial biochemistry, space biology, and exobiology. He was leader of the Viking biology team which performed automated life detection experiments on Mars in 1976-1977. He also has flown biological experiments on two Soviet space missions, in 1977 and 1979. In 1977, he received the NASA medal for Exeptional Scientific Achievement. In 1981, he received the NASA medal for Outstanding Leadership and also was the recipient of a Presidential Meritorious Service Award.

Dr. Klein received a B. A. degree in chemistry from Brooklyn College in 1942 and a Ph.D in bacteriology from the University of California in 1950.

He is a member of several professional societies including Phi Beta Kappa, the American Society for Microbiology, the American Society of Biological Chemists, and the International Academy of Astronautics.

He has served on several advisory committees to NASA, including the Planetary Biology Subcommittee, the Interagency Committee on Back Contamination, the Research Advisory Committee on Biotechnology and Human Research, the Joint U.S./U.S.S.R. Working Group in Space Medicine and Biology, and the NASA Life Sciences Steering committee. He is an editor of the journal Origins of Life, and referees papers for other journals, including Science, Icarus, Plant Physiology and Journal of Molecular Evolution. Currently, he is on the Space Sience Board of the National Research Council and is chairman of the AIBS peer review panel on exobiology.

Dr. Klein and his wife, Gloria, live in Palo Alto. Dr. Klein was born in New York in 1921.

Mr. NELSON. We thank you.

We will go now to vote and will return shortly.

[Recess taken.]

Mr. NELSON. Why don't we resume? Fortunately, I made it. It was the foreign aid bill.

[Laughter.]

Mr. NELSON. Dr. Klein, do you have a plane to catch?

Dr. KLEIN. A 1 o'clock flight.

Mr. NELSON. OK. Well, from where, from National or Dulles?

Dr. KLEIN. National.

Mr. NELSON. All right. Well, I think you're in good shape.

Dr. KLEIN. It looks like it.

Mr. NELSON. So we will proceed.

Dr. Smith?

Dr. SMITH. Mr. Chairman, it is a privilege to appear before the subcommittee and to have the opportunity to offer my personal views on the question of increased cooperation between the United States and the Soviet Union in civilian space research.

As an astronomer and planetary scientist I have been fortunate enough to have a number of mutually beneficial scientific exchanges with various Soviet colleagues over the past 20 years. The very earliest of these was a program of coordinated telescopic observations with a colleague in the Kazakh, Soviet Socialist Republic, and the most recent has been my involvement with the Vega experiment, the Hungarian imaging experiment on the Vega.

My scientific exchange with the Kazakh astronomer was, of course, informal in nature. It didn't involve the involvement of either Government, and went very smoothly. In contrast, however, my participation in the Vega project, I was required to have official Government approval at various levels and, in fact, was formally sanctioned only after about 22 months of occasionally frustrating negotiation among various agencies in this country and in Hungary. The Soviet Government was, of course, not directly involved in any of these negotiations, but it's clear that my participation in the Vega mission has been possible only with the implicit approval of the Soviet Government.

Before discussing my own views on the merits of improved cooperation, I would just like to mention one earlier attempt on my part to bring about some East-West collaboration in our solar systems exploration.

During the late 1970's as the Voyager spacecraft were on their way to Jupiter, I made an effort to have a senior Soviet scientist and expert on the global circulation of deep planetary atmospheres added to the Voyager imaging science team. And I made a proposal to negotiate such an appointment with NASA.

My reasons for proposing the Soviet participation were twofold. First of all, such a step might have led to an expanded program of East-West exchange of planetary scientists on future flight programs, and second, the proposed Soviet theoretician would have provided additional strength in an area of expertise where the Voyager imaging team is weak.

Now, admittedly, in this particular type of exchange, the Soviet Union might have well derived the greater benefit in that they would have had their own scientist on the Voyager imaging team

and would have had direct access to all of the raw data. However, there was good reason to believe at that time that the Soviet leadership would respond by inviting American participation in their very successful Venus program.

Getting back to my Vega involvement, in March 1981 I learned that the two Soviet Venera spacecraft, which were being modified to include a Halley flyby, would carry CCD cameras. These cameras were designed and fabricated by the Hungarian Central Reseach Institute for Physics, or CRIP, as they are sometimes known, and these cameras would employ Soviet-made CCD detectors.

When it became later apparent to me that there was to be no U.S. mission to Halley, I expressed an interest in the Hungarian Vega experiment to some mutual colleagues.

Mr. NELSON. Where?

Dr. SMITH. Both. There have been Hungarian scientists from the Central Reseach Institute of Physics that have been both at the University of Arizona and at the University of Michigan, and through a combination of Michigan and Hungarian scientists this invitation finally came about.

In fact, in August of 1982 I was invited to become a member of the Hungarian imaging team, and with full data and publication privileges.

My contribution was to include assistance with data processing, and the scientific interpretation of the processed data. From my point of view, this was an idea arrangement. It promised to be mutually beneficial to all concerned.

As it turned out, however, this view was not universally embraced, and it wasn't until July 1984, some 22 months later, that the final versions were arrived at.

Involved in these discussions or the agreements with the University of Arizona and CRIP at one level and NASA and Hungarian Intercosmos at a higher level, and it also involved the State Department, the Defense Department, and at least interagency committee.

Although the language of the parallel agreements between Arizona and CRIP, between NASA and Intercosmos were worked out quite easily, there were a series of delays that were created by the other agencies which were involved because of primarily concern over technology transfer, and in particular, the area of digital image processing.

Now, I want to make it clear to this committee that the image processing software which is being developed by Arizona for use on Vega is built upon commonly used and widely distributed routines that have been employed for nearly a decade in astronomical data processing, particularly image processing. And although this point was very clearly understood by the Office of Space Science at NASA, by the Office of International Affairs at NASA, it was perhaps not fully appreciated by the other U.S. agencies.

The fact that this country stood to gain a valuable and unique collection of space data at very little monetary cost and at no measurable risk to national security was apparently not immediately recognized, anyway, by the Departments of State and Defense.

Mr. NELSON. Why do you think that's so?

Dr. SMITH. I beg your pardon?

Mr. NELSON. Why do you think that's so?

Dr. SMITH. Because it was held up for such a very long period of time in spite of our efforts to convince them that we were really talking about the type of software that a graduate student might sit down and work out in a week or so. In other words, we were not talking about state-of-the-art software.

I think perhaps that the process of achieving these agreements was, in my view, unduly lengthy and difficult. This may have been due, in part, to the lack of a bilateral agreement in space cooperation between the United States and the Soviet Union.

The 22 months required to generate the Vega agreements placed a rather large demand on my own personal time, and I would have to say quite candidly that if the procedure could not be made simpler, that I would not be willing to expend that amount of effort a second time.

Finally, I would like to state my own belief that there is much to gain and very little to lose through increased cooperation with both the Soviet Union and Eastern Europe in space research. And as the Soviet Union moves ahead in solar system exploration with programs of ever-increasing complexity and sophistication, it becomes more important than ever that the research initiatives of both countries be complementary rather than competitive.

One of the simplest, and yet effective, ways of achieving cooperative participation and the sharing of scientific data is through the exchange of appropriately qualified scientists on each other's space experiment teams.

To merely share this data is insufficient. The interpretation of numerical data without an intimate understanding of how these data were acquired, how they were calibrated, is very, very difficult, and occasionally impossible. There is no substitute for having direct scientific participation, personal participation, on these experiments.

One might hope, then, that the exchange of scientists would lead ultimately to an exchange of individual experimental payloads on each other's spacecraft and finally, perhaps, to joint missions in space.

Discussions that I have had with senior Soviet space officials suggest that they are still very willing to cooperate with the United States in civilian space research. But as they move ahead with their highly advanced Phobos and Vesta programs, it's becoming clear that they may be on the verge of overtaking the United States in deep space research. The Vega experience has already demonstrated an eagerness by the West European scientific community to engage in East-West scientific partnerships with the Soviets on Soviet missions. Therefore, the Soviet Union may rapidly be approaching the point where there are no longer any compelling benefits in cooperating with the United States.

I would point out that had the exploration of the Antarctic continent been carried out by only a single powerful nation, there might never have been multinational bilateral agreements, multinational agreement prohibiting its exploitation.

I think this is a lesson, the failure on the part of this country to recognize the ever-increasing capability of the Soviet space program and that mutual benefits of cooperation and coordination

might eventually leave us in a position of having to choose between a costly program of catching up or the prospect of conceding the inevitble colonization of the system to the Soviet Union.

As a final note, I would certainly support Dr. Simpson's suggestion that there be some sort of a line item in the budget to allow for this cooperation. The way it's done right now is a very haphazard, ad hoc method. Some particular individual has a particular contact with somebody in the Soviet Union and so an experiment or an investigative arrangement is set up.

That is probably not the best way to do it. It ought to be done as we do in the past, through the normal peer review process; that is, the Soviets would announce that a particular experiment would be open to U.S. investigators and one should go through the peer review process of deciding just who those people should be.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Smith follows:]

STATEMENT TO THE SUBCOMITTEE ON SPACE SCIENCE AND APPLICATIONS

COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

Dr. Bradford A. Smith

Professor, Department of Planetary Sciences
University of Arizona, Tucson, Arizona

Hearing: U.S.-Soviet Civilian Space Cooperation
July 31, 1985
Rayburn House Office Building
Washington, D.C.

Mr. Chairman and Members of the Subcommittee:

It is a privilege to appear before this subcommittee and have the opportunity to offer my personal views on the question of increased cooperation between the United States and the Soviet Union in civilian space research. I am especially interested in this particular subject because, as an astronomer and a planetary scientist, I have enjoyed a number of mutually beneficial scientific exchanges with various Soviet colleagues over the past twenty years. The very earliest of these scientific collaborations involved coordinated telescopic studies of the atmospheres of Jupiter and Saturn. Accomplished almost entirely by correspondence, this particular collaboration was merely an informal exchange of observations and ideas between myself and a Soviet colleague in the Kazakh S.S.R. The most recent involvement has been my participation as a team member of the Hungarian imaging experiment on the Soviet Venera-Gallei (VEGA) mission to Halley's Comet.

My scientific exchange with the Kazakh astronomer was informal in nature, and thus did not require the direct involvement of either government. In sharp contrast, however, my participation in the VEGA project was required to have official approval by several governmental organizations, and was formally sanctioned only after 22 months of occasionally frustrating negotiation among various agencies of the Hungarian government and our own. I should make it clear that the Soviet government was not directly involved at any time during these negotiations; however, it must also be clear that my participation in the VEGA mission has been made possible only with the implicit approval of the Soviet government.

Before discussing the merits of participation by American scientists in Soviet space programs, I would like to mention one earlier attempt on my part to bring about East-West collaboration in the exploration of our solar system. In the late seventies, as the Voyager spacecraft were on their way to Jupiter, I made an effort to have a senior Soviet scientist, an expert on the global circulation of dense planetary atmospheres, added to the Voyager imaging science team. A proposal to negotiate such an appointment was made to NASA management following informal, preliminary discussions with the Soviet scientist during one of his visits to this country. At that time, of course, the bilateral space-cooperation agreement with the Soviet Union was still in effect, and visits by Soviet space scientists to the United States were far more frequent then than they are now, in this current political environment. My reasons for proposing Soviet participation in the Voyager project were twofold: first of all, such a step might have led to an expanded program of East-West exchange of planetary scientists on future flight programs, and secondly, the proposed Soviet theoretician would have provided additional strength in an area of expertise where the Voyager imaging team was weak. Admittedly, in this particular exchange, the Soviet Union might well have derived the greater benefit, i.e., direct access to the unprocessed imaging data through the membership of a Soviet scientist on the Voyager imaging team. However, as I have already stated, there were good reasons at that time to believe that the

Soviet scientific leadership would respond by inviting American participation in one or more of their highly successful missions to Venus. My proposal, unfortunately, never got beyond intermediate administrative levels at NASA Headquarters.

Let me now return to the VEGA project - how I happened to be associated with it and how, in my opinion, such cooperation between this country and both the Soviet Union and Eastern Europe could be mutually beneficial. Several years ago I, along with several other members of the space science community, had attempted to raise awareness within the Administration of the importance of a U.S. space mission to Halley's Comet. With our preliminary survey of the solar system now nearly complete, the small, primative bodies, including comets and asteroids, remain as a final but very important, unexplored component of the total system. Such bodies, especially comets, hold essential clues to the origin and evolution of our solar system and, quite probably, to the origin of life itself. The crucial factor in the significance of comets is that their material is unprocessed, i.e., that comets remain today in much the same physical and chemical state as when they were created more than 4.5 billion years ago. Among those relatively few comets with known and, therefore, predictable orbits for spacecraft encounters, Halley appears to be the most pristine. The decision by NASA and the Administration not to include a space mission to Halley's Comet came, therefore, as a great disappointment to many of us.

In March 1981, however, I learned that two Soviet Venera spacecraft which were being modified to include a Halley flyby would carry CCD cameras, designed and fabricated by the Hungarian Central Research Institute for Physics (CRIP) and employing Soviet-made CCD detectors. When it later became apparent that there was to be no U.S. mission to Halley, I expressed an interest in the Hungarian VEGA experiment through mutual colleagues.

In August 1982, I was invited to become a member of the Hungarian imaging team with full data and publication privileges. My contribution to the VEGA team was to include assistance with data processing and scientific interpretation of the processed data. From my perspective at that time, the proposed arrangement would be ideal, in that it promised to be mutually beneficial to all concerned. As it turned out, however, this view was not universally embraced, and it was not until July 1984, some 22 months later, that the final versions of the agreements were approved. Involved were the University of Arizona and CRIP, NASA and Hungarian INTERCOSMOS, as well as the Departments of State and Defense and at least one interagency committee. Although the language of the parallel agreements between the University of Arizona and CRIP and between NASA and INTERCOSMOS was worked out with relative ease, a series of delays was created by the other agencies involved, because of concern over technology transfer, particularly in the area of digital image processing. Now, I want to make it clear to this Subcommittee that the image processing software being provided by the University of Arizona to the VEGA project is built upon commonly used and widely distributed routines that have been employed for nearly a decade in astronomi-

cal data processing. Although this point was clearly understood by both the Office of Space Science and the Office of International Affairs at NASA, it was perhaps not fully appreciated by the other U.S. agencies involved. The fact that this country stood to gain a valuable and unique collection of space data at very little monetary cost and at no measurable risk to national security was apparently not immediately recognized by the responsible offices in the Departments of State and Defense. Eventually, the agreements were approved at all levels, but the effort expended seems to be incommensurate with what one might expect for a simple cooperative collaboration in a civilian space project.

I cannot help but feel that the process of achieving those agreements that made possible my participation in the VEGA mission was unduly difficult and lengthy, and that this was due in part to the lack of a bilateral space-cooperation agreement between the United States and the Soviet Union. Throughout the interagency evaluations of the VEGA proposal in this country, it was always tacitly understood that there was a real, but unrecognized, third partner in the cooperation - the Soviet government. However, because the bilateral space agreement with the Soviet Union had been allowed to lapse without renewal in 1982, the process of obtaining U.S. governmental approval of the VEGA agreements seems to have been impeded by a certain amount of offical foot-dragging.

The 22 months required to generate the VEGA agreements placed rather large demands on my own time, and I should add, parenthetically, that, were it not for the unwavering support of NASA's Office of International Affairs, the process would have been even more difficult and time consuming. If other American scientists are to take part in future Soviet missions, I would ask that ways be found to minimize the bureaucracy. Quite candidly, I would not be willing to expend the same amount of effort a second time.

Finally, I should like to state my own belief that there is much to gain and very little to lose through increased cooperation with both the Soviet Union and Eastern Europe in civilian space research. As the Soviet Union moves ahead in solar system exploration with programs of ever increasing complexity and sophistication, it becomes more important than ever that the research initiatives of both countries be complementary, rather than competitive. One of the simplest, yet effective, ways of achieving cooperative participation and the sharing of scientific data is through the exchange of appropriately qualified scientists on each other's space experiment teams. To merely share data is insufficient; the interpretation of numerical data without an intimate understanding of how the data were obtained and processed is difficult at best and frequently impossible. There is no substitute for direct participation in scientific data gathering. One might hope that exchange of scientists would then lead to the acceptance of scientific instrument payloads on each other's spacecraft and eventually to joint missions in deep space.

Discussions I have had with senior Soviet space officials indicate that there is still a great willingness on the part of the Soviet Union to cooperate with the United States in civilian space

research. But, the Soviets now seem to be on the verge of overtaking the United States in deep space research, and the VEGA experience has already demonstrated an eagerness by the West European scientific community to engage in East-West scientific partnerships on Soviet space missions. Thus, the Soviet Union is rapidly approaching a capability in which there might no longer be any compelling benefits in cooperating with the United States.

Had the exploration of the Antarctic continent been carried out by only a single, powerful nation, there might never have been a multinational agreement prohibiting its exploitation. Failure on the part of this country to recognize the ever increasing capability of the Soviet space program and the mutual benefits of cooperation and coordination might eventually leave us in a position of having to choose between a costly program of catching up or the prospect of conceding the inevitable colonization of the solar system to the Soviet Union.

BIOGRAPHICAL SKETCH
Bradford A. Smith

Born September 22, 1931 in Cambridge, Massachusetts. Attended public schools in Winchester, Massachusetts. Received a Bachelor of Science degree in Chemical Engineering from Northeastern University in 1954. Awarded the Doctor of Philosphy in Astronomy from New Mexico State University in 1972, with graduate research in theoretical and observational planetary geophysics.

Present Position: Professor in the Department of Planetary Sciences and in the Lunar and Planetary Laboratory, and Astronomer in the Steward Observatory, University of Arizona; at the University of Arizona since 1974. Also, Associate Director of the Lunar and Planetary Laboratory. Teaches both professional research and general education courses at graduate and undergraduate levels.

Research and Publications: Research and publications in astrophysics and planetary geophysics. Observational studies employing groundbased telescopes, earth-orbital instruments and planetary spacecraft. Studies of extra-solar planetary systems, planetary atmospheric dynamics, geophysical processes in solid bodies, phenomena associated with planetary rings and the physics of primitive bodies in the solar system. Space Science activities include: Television experiment, Mariners 6 and 7; Deputy Team Leader, Television experiment, Mariner 9; Landing Site Adivsory Committee and orbital imaging experiment, Viking; Team Leader, imaging experiment, Voyager; Wide Field/Planetary Camera, Hubble Space Telescope; Imaging experiment, Venera-Gallei (VEGA) spacecraft to Venus and Comet Halley.

Previous Positions: U.S. Army Map Service, 1955-1957; Research Scientist, rocket instrumentation, Physical Sciences Laboratory, New Mexico State University, 1957-1960; Research Scientist, Department of Astronomy, 1960-1968 and Director of Planetary Research, Department of Astronomy, New Mexico State University, 1968-1974; Visiting Associate, Division of Geological and Planetary Sciences, California Institute of Technology, 1969-1972; Associate Professor, Department of Astronomy, New Mexico State University, 1973-1974.

Awards, Honors, Societies: NASA Medal for Exceptional Scientific Achievement, 1972 and 1981; University of Arizona Alumni Distinguished Citizen of the Year Award, 1982; New Mexico State University Distinguished Alumnus Award,1983; International Astronomical Union, President of the Commission on Physics of Planets and Satellites, 1979-1982; International Council of Scientific Unions; COSPAR; American Astronomical Society, Division for Planetary Sciences. Research grants from the National Aeronautics and Space Administration and the National Science Foundation.

Other Activities: Various scientific consulting and advisory committees including Solar System Exploration Management Council (NASA), Space Telescope Institute Council (AURA), Arecibo Advisory Board (NAIC and Cornell University), CSAA Space Telescope Task Group (NRC), Space Science Research in the United States Project (OTA) and Working Group for Planetary System Nomenclature (IAU). Also various science working groups for the planning of planetary missions (NASA).

Addresses: Office: Department of Planetary Sciences, University of Arizona, Tucson, AZ 85721; (602) 621-6930. Home: 502 E. Deone Circle, Tucson, AZ 85704; (602) 297-2767.

Mr. NELSON. Thank you.

Mrs. Meyers, will you take the chair while I run and go vote? You have already voted?

Ms. MEYERS [presiding]. Yes.

Mr. NELSON. OK. Fine. There is another vote in progress.

Dr. Masursky?

Mr. MASURSKY. You have a copy of my statement, so I will summarize a few things from it. I have been involved in the space program since 1962, when I started with telescopic observations of the Moon and I have worked on the unmanned pre-Apollo flights.

Ms. MEYERS. I wonder if maybe you could move the mike a little closer to you. I think those in the back of the room are having some trouble hearing you.

Mr. MASURSKY. Yes. I have worked on a number of the space flight projects, including the unmanned pre-Apollo flights. I worked closely with the astronauts and the system at Johnson during Apollo in preparation of materials to choose the landing sites and to organize the tasks that would be done on the surface. Since that time, I have been involved in flights to Mars, Venus, and the outer planets.

During all of that time, we have had a parallel Soviet effort that has been going on, and we've had many contacts with them. We had a formal planetary data exchange group that occupied—or that was, I think, engendered in 1971 and ran until 1981. I think there were two 5-year periods, and we did not renew that agreement in 1982.

During that time, we've had a number of exchanges. We received from the Soviets copies of their first lander pictures on the Moon, and their first maps of the lunar far side. We ran our very successful pre-Apollo program and succeeded in mapping essentially the entire Moon in great detail.

They talked about diverting from the manned program when they had difficulties with that program, and went into an intense unmanned effort where they landed rovers that were teleoperated from Moscow on the Moon surface and landed and brought back samples.

The one I was most impressed with is they had an unmanned small drill that sampled 2 meters, brought it back into the spacecraft in a coil, and returned to Earth. I thought that was a considerable technical feat.

We worked closely with them in their efforts to explore Mars while we also had a very active program, and they had a series of catastrophes. Their final effort was Mars 5 and 5. They had two orbiters and two landers. One of the orbiters flew by, taking a swath of data as it went by. It didn't go into orbit. Both landers failed. They went into orbit with the second orbiter and managed to get 11 passes.

But they provided us with considerable detail. We were much interested in the Mars atmosphere and the action of a parachute because we were planning to use parachute slowdown of our Viking spacecraft. And they had the data during the descent through the atmosphere, and they provided us with excruciating detail on the failures of their various spacecraft and also the data they had received on the parachute descent that was incorporated into the

testing of the Viking parachute. And our spacecraft, of course, worked beautifully in that case.

Then we got involved in the Venus exchange, where they have had a very active program of, first many failures, and then since Venera 8, the first seven were failures of various kinds, and they have had great success with the Veneras and the Vega's since that time.

We were flying Pioneer Venus. That is still orbiting Venus, and we have mapped the entire planet with radar.

And then they were planning landings. And earlier they had landed on Venus at the point on the planet so at the time of the landing it would be directly under the Moscow tracking station. So it was the telecommunication link that decided the landing spots.

They got a little more ambitious later, and we've prepared maps advocating particular places. And they landed in those spots, and they returned chemistry from the surface that we were able to incorporate in our maps, because we said these are particular shapes so they must have a particular geologic composition. And it turned out that our prejudices were fully borne out by the chemistry. So we think their chemistry must have been right, since it agreed with our hypotheses.

Since then they have landed Vegas 1 and 2, and again we've worked closely with them on the definition of the landing places. We wanted them to land some 10 degrees farther west. Unfortunately, they were flying on to Halley, so they had a very restricted zone on Venus that they could land in. But we discussed what would be most advantageous scientifically, and the landings took place in those areas.

They lost the sampling device on the first Vega. But they did get gamma ray data. Each time they've flown a spacecraft, it has been more advanced, more sophisticated, better instrumentation. So we anticipate that they will shortly release the data.

Meanwhile, when we cancelled our Venus orbiting imaging radar mission, they had recessed their planned radar flight because we were going to fly in 1981. When that mission was cancelled, they took their spacecraft out of cold storage and managed to launch it in a year and a half. I think that was a notable feat.

I sometimes think in our style of doing business now, that we could not name a science working group in that time, let alone launch the spacecraft. We used to do things like that very nicely, say, in 6 months.

They got beautiful radar pictures. Our anticipation was that, No. 1, they didn't have synthetic aperture radar; No. 2, that they couldn't digitally process it; and No. 3, that they couldn't do image processing and make computer mosaics. All of that supposition turned out to be wrong. They did very nice jobs on all three of those.

They have also been very generous in providing those images, because we're planning our substitute smaller mission, the Venus radar mapper. We use those pictures to go in and suggest an increase in the resolution, and we were successfully able to get a factor of two.

We wanted a factor of four, but we thought that was a considerable victory because we could point to specific features on the

Venus surface that we could not interpret with the quality of their data, and they agreed wtih us that we really needed a factor of 10 better than their data in order to properly interpret these things. And we got a factor of five. So I think we're a little marginal on settling some of the scientific issues that we know are there.

We will fly our Venus radar mapper in 1988. Brad earlier mentioned the Vesta mission. It's a very ambitious 1991 Venus mission, where they anticipate—I think they're calling it the International Venus Mission, and they will have participation not only by the Eastern bloc countries but even more participation by the Western Europeans.

I think that this—again to follow Brad's statement, there are very sophisticated scientists with very sophisticated instruments. I don't think that we need to worry about their lagging significantly behind us.

They have announced the Phobos mission to Mars in 1988, an extraordinarily ambitious mission, as was the Vega. And we anticipate that their failures have dramatically decreased. So they are going to rendezvous with the little moon of Phobos that circles Mars and stand off from it and zap it with a high-energy beam and analyze the products.

Our people have been very interested because we don't have anything quite that ambitious in mind at the moment.

We see them proceeding at a great rate. Their efforts have not slowed down at all. Each time, the missions become more complex, more sophisticated—the spacecraft, the navigation, the instrumentation. We see them making great progress.

I wanted to quote from a recent communication. Makarov, one of their cosmonauts, says, "We can do all of these things alone, but that would be ridiculous and wrong for us to carry out these things by ourselves." And a quote from Barsukov, who has pushed us very, very hard to enter into cooperative agreements—at the Houston meeting last March, they announced a lunar mission in 1989 or 1990. We've had on our books a lunar mission for 1992.

I anticipated that the announcement of their lunar mission was deliberate. And in fact, they have now said so. That is, "If you won't work with us, we will go ahead on our own." And Barsukov says, "Of course, the West is eager to cooperate with us now because we are 2 to 4 years ahead of them. You know, we've mapped Venus. Now the United States isn't going to do it until 1988. We're going to fly a lunar mission in 1989; they won't fly one until 1992."

So I see a change in their attitude. In the early years they tried to beat us to each scientific objective. The literature is widely disseminated on our future plans, and they tried to do things before us, and succeeded many times. Many times we did things later but so much better that the community has, in essence, forgotten that the Soviets beat us to a particular thing.

But since they are getting more ambitious and better with better instrumentation, I don't think that may be the case in the future. So I see their Phobos mission is complementary to our Mars mission that will fly a couple of years later. The lunar mission is a direct competitive effort.

So what I am afraid I see is a return to, instead of the complementary science that they were very careful to adjust their mission

to do things other than what we were doing during the time the agreement was in force, now I see a very mixed reaction and the most recent one is we're going to do what you're going to do, earlier. And that seems to me wasteful, because I was on a committee that laid out a future program that said what we need to do is to fly modular spacecraft, we need to save money on operations, we need to make sure that we're not doing something that somebody else is going to do, and we bring the cost down by international cooperation.

And as my last statement, we heard earlier today from Charles Horner that we should pay attention to cooperation. Well, we're doing that. I have spent 2½ years on a joint NASA-ESA plan to have a Saturn orbiter and Titan probe, the Cassini mission. We're finishing the final report on it. We anticipate doing that mission, and we think the French will build the probe, and we'll build the orbiter.

We couldn't do that, I don't think, and fit it into our budget now. The Japanese have announced a lunar orbiter in 1995. We're going to fly one in 1992. The Soviets, in 1989. We've talked with the Japanese, and they say, well, maybe if they push real hard, they can bring it up to late 1992 or 1993. But instead of a simple orbiter, we hope maybe we'll fly penetrators, which will go down to the surface. We'll have a relay station so we can map the far side gravity. In other words, with Japanese cooperation, we will be able to do things that we could not do on our own and fit them into our budget.

Now, I have visited the Soviet Union after Viking, and we gave a talk in the Moscow Space Research Institute, and we had about 300 people at the meeting, only unlike most of the places where we gave talks, they were not interested scientists, they were all space workers. These were all people who were engineers and scientists and technicians who, in fact, worked on space missions. There is no place else in the world that we can do that. They're big league. And they're getting better all the time.

So I am in favor of the cooperation, because if we do it, we will be able to do things that we might not be able to do by ourselves. But we are trying very hard to do cooperative things with the Europeans and the Japanese simultaneously.

Thank you.

[The prepared statement of Mr. Masursky follows:]

STATEMENT
OF
DR. HAROLD MASURSKY

before the

SUBCOMMITTEE ON SPACE SCIENCE AND APPLICATIONS
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

July 31, 1985

Mr. Chairman, I am Dr. Harold Masursky, appearing as a technical witness to describe my work with Soviet space scientists for the past 16 years. My statement today does not necessarily represent the position of the U.S. Geological Survey or the Administration on the overall problems or the potential benefits inherent in U.S.-Soviet cooperative ventures. My testimony is based only on my personal experience with U.S.-Soviet cooperation in space research and development efforts.

I was educated at Yale University and Northern Arizona University. I have been employed by the U.S. Geological Survey since 1946; during the first 16 years of my career I worked in many States carrying out terrestrial geologic investigations. I have worked on NASA space flight projects since 1962, when we began to make systematic geological maps of the Moon from earth-based telescopes.

Lunar and Planetary missions on which I have worked are as follows:

Inner Planets

Moon - Ranger, 1964; Lunar Orbiter, 1966; Surveyor, 1966; Apollo, 1969-70
Mars - Mariner 9, 1971; Viking, 1976
Venus - Pioneer Venus, 1978; Venus Radar Mapper 1988

Outer Planets

Voyager - Jupiter, Saturn, Uranus, Neptune, 1979-1989
Galileo - (Jupiter Orbiter Probe), 1988

I began working with space scientists from the U.S.S.R. at the Tokyo COSPAR (Committee on Space Research) meeting in 1968 and have worked closely with them since the Leningrad COSPAR meeting in 1970. I was a member of the Joint Planetary Data Exchange Group that first met at the Madrid COSPAR meeting in 1972. It continued to meet intermittently until 1981, when its last meeting was held in San Francisco. The space agreement was not renewed in 1982.

We have worked closely with Soviet scientists on lunar studies, trading photographs of the Moon taken by the U.S.S.R. Zond 8 and the U.S.A. Lunar Orbiter. We prepared maps for their Lunakhod (rover) missions. Later the U.S.A. and the U.S.S.R. traded lunar samples returned by the Apollo and Luna missions.

We prepared maps of their proposed Mars 4 and 5 landing sites on Mars. The entry data obtained by their unsuccessful lander probes gave valuable information concerning parachute performance in the Mars atmosphere which was used by design and operations teams of the Viking landers. They also provided copies of photographic data and digital tapes taken by the Mars 4 and 5 orbiters.

We have prepared landing site maps for Venus landers on their Veneras 9, 10, 11, 12, 13, 14, and the current Vega and 2 missions that will continue on to rendezvous with Halleys Comet. They have provided us, in advance of publication, panoramic pictures of the Venus surface and chemical data obtained by these missions. They have also provided many radar images obtained by the Venera 15 and 16 orbiter spacecraft before publication. These pictures assisted in the redesign and improvement of our radar experiment that will fly in 1988 to map Venus at higher resolution and with more complete

coverage. They have indicated recently that they will provide some digital altimetry and digital radar images from Venera 15 and 16 next month.

We will fly our Mars Observer mission in 1990; they will fly their Phobos (a satellite of Mars) and Mars mission in 1988. We can cross-calibrate their data with that obtained by similar instruments on the Mars Observer and thus, by comparison, amplify our observations. We did cross calibrations of this type, after the fact, for our Pioneer Venus mission and their Venera missions. Based on my experience, U.S.-Soviet exchanges have been mutually beneficial and should continue to be so in the future.

Recently the U.S.S.R. announced a Lunar Orbiter mission that will fly in 1989 or 1990. Our Lunar Observer will fly in 1992, according to the current plan, with a similar payload; however our instrumentation will be more advanced. The Japanese announced a Lunar Flight in 1995 but changed to 1992 last month (June 1985). There may be some benefit in coordinating, if not cooperating, in this next round of lunar exploration. Since the lapse of our agreement in 1982, the Soviets with whom we have met have very urgently pushed us to renew the space agreement and to work cooperatively. The recent announcement of their lunar mission indicates to me that they may have changed their thinking; that is, they may be unclear whether we intend to renew the agreement and therefore they will go it alone, if necessary. Attached are transcripts of recent Soviet communications in which Dr. Valeriy Barsukov, head of the Vernadskiy Institute of Geochemistry and Analytical Chemistry, and Cosmonaut Makarov's comment on the present state of cooperation.

It appears to me that we have gone through three phases in USA/USSR space relationships:

1) Competition: 1958-1972; they tried to beat us to all space objectives.

2) Complementary investigations: 1973-1982, they modified their objectives to do other things.

3) Current contradictions: 1981 to present; they are doing some complementary things but others that are directly competitive.

This concludes my statement. I will be happy to answer any questions you may have.

Attachment

USSR SCIENTISTS AGAINST SPACE MILITARIZATION

LD121615 Moscow TASS in English 1507 GMT 12 Jun 85

["Soviet Scientists Protest Against Space Militarization"--TASS headline]

[Text] Moscow June 12 TASS -- "Soviet Scientists are unanimous in the opinion that space should be an arena of peace and cooperation", Valeriy Barsukov, a corresponding member of the Academy of Sciences of the U.S.S.R., told a TASS correspondent. He stressed that Soviet scientists did a lot to promote peace and curb the arms race.

A majority of American scientists with whom I have lately met and talked, Barsukov went on to say, are also convinced that space militarization is madness and a threat to the security of the United States itself. It is not accidental that 700 American scientists signed an address expressing their concern over the development of anti-satellite weapons and an anti-ballistic missile defense system with space-based elements.

There are many of my acquaintances among the signatories of the address. For many years now we have had meetings in the United States and the Soviet Union, the Soviet scientist said.

Not infrequently we conduct parallel development work to design the same instruments for the study of physical processes and phenomena taking place in the universe, spending a lot of efforts and funds. But the instruments are practically the same, Valeriy Barsukov said. If it wasn't for the complex international situation that deteriorated through the Reagan administration's fault we could pool our efforts in the study of many scientific problems, including energetics, environmental protection and space exploration.

Soviet science, and I can say so with assurance, has not suffered because of curtailed scientific contacts, Barsukov said. In the past few years the U.S.S.R. has achieved notable successes in the study of a number of planets, Venus, for example, and this enabled Soviet scientists to overtake their colleagues from other countries. This leadership is recognized by American specialists who sometimes have to repeat and plan research already carried out in the U.S.S.R. For instance, Soviet scientists have already compiled the map of Venus, while the Americans plan to do so in 1988.

((Editorial Report)) Moscow domestic service in Russian at 1430 GMT on 24 June carries a 15-minute report by Petr Pelekhov on the contrasting aims of Soviet and U.S. space exploration and research.

The report continues with a statement by Cosmonaut Makarov, a veteran of the Soviet Space Program.

In this connection he turns to the Soviet Space Program, which, he says, has been working on extending its manned flights so that men will be able to visit Mars. This, he notes, requires a huge amount of money, though not as much as Star Wars, and technological development. Makarov refers to other plans requiring international cooperation, including the plans for using solar energy on Earth, or for a huge radiotelescope that will have one part on Earth, and the other a couple of million kilometers away and will work together. This project, he says, will cost nothing in comparison with Star Wars. Makarov continues: "it is possible to risk attempting this alone as we have already shown that we can accomplish much alone; however, it is quite obvious that is ridiculous, and wrong." Makarov concludes by noting that space can be used for disarmament or for the arms race.

Pelekhov then gives examples of international cooperation that have already taken place.

Valeriy Leonidovich Barsukov, corresponding member of the Academy of Sciences and Director of the Vernadskiy Institute of Geochemistry and Analytical Chemistry, is then heard. He says that at a conference in Houston this March, U.S. scientists displayed much interest in Soviet research. Barsukov notes that they wanted to take part in the planetary exploration not only passively, by receiving the signals from Venus themselves, but by suggesting large-scale joint experiments, such as establishing moon bases, studying Mars, and so on. He continues: "They are very interested in such cooperation because it has transpired that the Soviet program is significantly ahead of the American one in the study of near-earth planets. Practically all the experiments which we are conducting, have conducted, or plan to conduct are being planned by American specialists as well, but with a lag of 2-4 years. Thus, they are extremely interested in reaching our level and working together." Barsukov concludes by stating that there currently is not as much cooperation as there might be because, according to him, the Americans broke the agreement. He says that the cooperation currently amounts only to an exchange of information and ideas, and asserts that proper agreements are needed. (ENDALL) 241430 MANTAS/JR 24/1944Z June

USA - USSR COOPERATION

SOLAR SYSTEM SPACE EXPLORATION

Three phases have been observed:

° Competition -- 1958-1972

USSR attempted to do each exploration task first.

° Complementary Investigations -- 1973-1981

USA concentrated on Mars Landers, Venus Orbiters and outer planet flybys - USSR on Venus Landers.

° Current Contradictions -- 1981-present

1. Since lapse of the space agreement the record is mixed - USSR Mars/Phobos complements USA Mars Observer.

2. USSR flew two radar mappers when VOIR was cancelled although we revived the smaller Venus Radar Mapper; they did not believe that we would fly our Venus mission.

3. USSR lunar polar orbiter is planned to fly two years ahead of USA Lunar Observer.

These actions indicate loss of expectation of USA agreement; it is a strong signal they will proceed without us with other international cooperation.

USSR Program

More open, ambitious, aggressive, more international (both eastern and western blocks) cooperation resulting in more sophisticated measurements and better science.

Ms. MEYERS. It's with great reluctance that I surrender this chair now. I do have a couple of questions, but I will forgo them, Mr. Chairman—I don't know what your timeframe is—so that we could hear from Dr. Klein.

Mr. NELSON [presiding]. Now let's be mindful of the gentleman's need to get his plane.

Anybody else? Are you going back up to the conference on that 1 o'clock flight?

Mr. MASURSKY. No. I have a later flight. I am going by NASA headquarters.

Dr. SIMPSON. I have a later flight.

Mr. NELSON. Let me ask Dr. Klein, in life sciences, if we were to look into this manned mission years down the road, from your specialty, do you see, since life sciences would be one of the areas that technology would really have to have some breakthroughs, are we talking about real sensitive stuff in research and development that it would be difficult for us to share in a manned mission to Mars with the Soviets?

Dr. KLEIN. In my own specialty, I would think not. I think we're dealing here more with the body, the human body and what it can or cannot do and how to support it. It's less a question of instrumentation than it is of just extension of prudent medical practice.

Now, of course, both we and the Soviets are trying to develop more and more sophisticated instrumentation to look inside the body without invasive procedures. I don't know whether this would be considered a sensitive area of technology. If we were to develop something exquisitely good, I just don't know how that would be construed by people like you.

Mr. NELSON. Well, certainly, a Mars mission would have to have some kind of closed loop——

Dr. KLEIN. Yes.

Mr. NELSON [continuing]. In the technology.

Dr. KLEIN. Yes.

Mr. NELSON. And that's a major breakthrough, isn't it?

Dr. KLEIN. That's a major breakthrough, and in my view the Soviets are working very hard. And I would say they are maybe 75 percent of the way toward doing that. They have at least two large simulators in which they put people and plants together for long periods of time, one in Moscow and one in Siberia. And the group in Siberia is coming, in my view, pretty close. They've kept people and plants together closed for up to 5 months without resupply. And I think that the next step is to make sure that that kind of technology will work in space, which is a whole other problem.

But once again I think the fundamental issues there are not technological. They are more questions of ecology, how you can put different kinds of living things together and not so much what kind of fancy gadgets you put in there. That's my view.

Mr. NELSON. Well, you certainly participated in quite a number of joint experiments starting back, you said, in 1974.

Dr. KLEIN. Yes, sir.

Mr. NELSON. Through the 1970's. And if I recall, you said in your testimony that it was almost unanimous among the Soviet scientists and cosmonauts that you were dealing with that they wanted joint missions. Was that your statement or someone else's?

Dr. KLEIN. That was not my statement. But I would certainly second that sentiment, that from all of my discussions over the past 15 years, that has been very much their attitude.

Mr. NELSON. That was your statement, Dr. Masursky.

Dr. MASURSKY. Yes.

Mr. NELSON. And on what basis do you come to that conclusion in your extensive dealings with them over the years?

Dr. MASURSKY. They've said it many times.

Mr. NELSON. They've said it?

Dr. MASURSKY. They've said it many times.

Mr. NELSON. In Tass, as a matter of fact? OK.

Dr. MASURSKY. Well, no, we have discussed this kind of thing a great many times over a great many missions, and they have said while the joint working group was meeting, "When are we going to get beyond the stage where we trade data on things that have already happened? You know, when are we going to get to the real business of this group that's supposed to be arranging cooperative things and do something substantial?

So I have heard this story many, many times from many different Soviets. So I believe that statement. Let's say if you hear it 20 or 30 times, then maybe it should make an impression.

Mr. NELSON. Ms. Meyers, if you have any questions for Dr. Klein, let's ask him so that we can excuse him and he can get on to the airport.

You will have plenty of time.

Ms. MEYERS. Would it be possible for the Soviets to put together a bare-bones——

Mr. NELSON. Use another mike. That one is not working.

Ms. MEYERS. Maybe I can just talk louder.

Mr. NELSON. The recorder has got to hear it.

Ms. MEYERS. Would it be possible for the Soviets to put together a barebones manned Mars flyby by 1992?

Dr. KLEIN. A flyby to return to the Earth?

Mr. MEYERS. Yes.

Dr. KLEIN. Back to the Earth or do you mean a one-way? I mean, they could do a flyby and not return people.

I don't think that it's in their psyche to do that. I think they have so many questions about the effects of long-term space flight on people, on humans, that I doubt that they would undertake such a venture as early as 1992.

Let me read you two sentences from Cosmonaut Grechko, who has flown on two of the Soyuz missions. Just to show you at least what one cosmonaut feels about long-term space flight.

He says—I am quoting him now:

> After three years in space—that is, a possible Mars roundtrip—you could not return to our planet. Your heart, your entire body would have adapted to life in space so that you could not stand it on Earth. Even after half a year of space travel—

Which they've done—

> It is difficult to walk and stand. You sleep poorly, and even eating is unpleasant at the start. After three years, the process is probably irreversible because there are significant changes during such a flight in your heart, your circulatory system, and your lungs.

Now, that's his statement. He is not an expert in medicine, but that's the way he feels as somebody who has been up there.

Ms. MEYERS. That's interesting.

Dr. KLEIN. And that attitude must permeate to other parts of the substructure. So I can't see them doing a barebones kind of mission that you are suggesting.

Ms. MEYERS. They are working on long-duration flights, though?

Dr. KLEIN. Absolutely.

Ms. MEYERS. Yes.

Dr. KLEIN. Very, very hard, and very well, very effectively.

Ms. MEYERS. Thank you, Dr. Klein.

Mr. NELSON. By the way, I am just interested, technologically, Dr. Klein, if in the manned Mars mission you could turn the spacecraft so that you could get some artificial gravity?

Dr. KLEIN. Again, that's not my area. I have heard people discuss that as a possibility. You could do that or have a piece of the spacecraft turning. We don't know whether you would need a continual artificial gravity.

Mr. NELSON. But from your standpoint as a specialist in life sciences, would that, with some measure of gravity, artificially induced, would that help the problem?

Dr. KLEIN. It would seem so. The Soviets have already shown that when animals are subjected to artificial gravity in space, almost all of the deterioration that they see in the various body tissues are prevented. So that's pretty good evidence that we should look in that direction.

Mr. NELSON. Before you take off, what kinds of information are we receiving from the Soviets, and how is this going to fit—the biological information—and how is this going to fit into our long-range plans?

Dr. KLEIN. Well, unfortunately, since the working groups' meetings have been suspended, our information flow is down to a trickle, and it involves just casual meetings at some international conference or other and sitting down in the hall or someplace and exchanging chitchat. And that's not the same as having 2 week long real work sessions with them as we used to have in the past.

So the information is not very good right now. If we have to wait for publications, the Soviets are notoriously slow if we have to wait until they write something.

Mr. NELSON. All right. We thank you for your participation.

Dr. KLEIN. It's been my pleasure. Thank you.

Mr. NELSON. I think you will be comfortable in getting out to National Airport. You have 50 minutes. I have learned how to get out there and get on the plane in 9 minutes. [Laughter.]

Dr. KLEIN. You've had more practice. [Laughter.]

Dr. MASURSKY. That does take some effort, though. [Laughter.]

Mr. NELSON. Well, I tried to do it last Friday, and it's a good thing that the plane was 10 minutes late. I got to National Airport in 7 minutes. However, there was a traffic jam on Friday afternoon.

OK, go ahead, Ms. Meyers. Do you have any other questions for the rest of the panel?

Ms. MEYERS. Just one for Dr. Masursky.

Is it your feeling—you mentioned in your testimony that the Soviets were doing some international cooperation, maybe more than we are at this point. Aside from the other benefits that we get from this kind of international cooperation, I think there is also a public relations benefit with the rest of the world.

Do you think that the Soviets are ahead of us in this regard and that other nations are regarding them as more willing to cooperate internationally than we are?

Dr. MASURSKY. I have a very strong memory of attending a Cospar meeting in Budapest, Hungary, 3 years ago. During the time of that international meeting there was a Hungarian cosmonaut who was flying overhead, and they landed, and he came back to the meeting and gave a talk. When we arrived in Budapest, there was an enormous picture of this Hungarian cosmonaut in every hotel, in every restaurant, in every building that I went into. Did they do pretty well on that? Yes.

Somebody had to think about that, let's say, 2 years ahead of time.

Ms. MEYERS. Yes.

Dr. MASURSKY. And plan this very nicely. So they study Madison Avenue very well and have picked up.

I think they work very hard at flying Third World cosmonauts and Eastern bloc cosmonauts. I think they have pushed harder and faster in this direction than have we. And I didn't say they were ahead of us in international cooperation, because we work very hard at it also. But they certainly project the image of being interested in it and have solicited international cooperation. So they are working very hard and very successfully in this arena.

Ms. MEYERS. Well, it seems to me that it's very important to us, even though it might seem superficial. Because if we establish this kind of relationship with other countries, it opens trade doors, too, I think. And that's extremely important to us. So in addition to the scientific benefits, I think there are many others.

Mr. NELSON. You know, back as far back as 1969 I was in Budapest, and it was right at the time of our launch of Apollo 11, and the place was going bananas. As I traveled on down the peninsula down into Yugoslavia, I mean, they were absolutely absorbed in the space program.

I will just tell you a little story. It doesn't have any relationship here. But I was a lieutenant in the Army, and we were about to launch from my home back at the Kennedy Space Center, and so I went to the Embassy to see if they were going to have any television of it. Of course, they weren't.

What I ended up doing so that I could participate in that historic event, I found the highest hill outside of Budapest, and I took my little shortwave radio and stuck up the antenna and got the BBC. They, of course, cut into Mission Control. So I was able to participate in the launch of Apollo 11 from a high hill outside of Budapest. I was going bananas. Several of the Hungarians around there didn't have any idea of what was going on.

All right, Dr. Smith, let me ask you about that exciting experiment that you have going on on Vega. What do you anticipate that you're going to get from this data? And I suppose that, you know, there is stuff that you're already getting?

Dr. SMITH. No, actually there are no data coming through yet. The imaging data will begin only just before the encounter of the two Vega spacecraft with Halley. Comets are primitive bodies. They represent probably the last really important component of our solar system that we have yet to study. They are totally unexplored to date. So as Vega approaches the nucleus of Halley, we will be getting the first view ever of a cometary nucleus. We have no idea whether it's solid, whether it's a conglomerate of loosely attached particles. We know very little of the environment of the nucleus, whether the nucleus is bright or dark.

Basically, we know—well, practically nothing about a cometary nucleus. Many of us made a considerable effort several years ago to try to convince the administration and convince NASA that it was a very important scientific objective to go to Halley. We did not succeed.

The very earliest effort now to be made by this country, if it survives, is the craft mission, a rendezvous mission to Cometville 2, which would happen sometime in the early 1990's at the earliest. So what it provides us with is the basic scientific observations of an object which is very, very poorly understood.

The Hungarians and the Soviet science working group that runs Vega have agreed to make these additional data available to us. We will do some data processing in Budapest at the time of the encounter and for some period thereafter, but then the tapes will be brought back to Arizona, and we expect to do further analysis with perhaps somewhat more sophisticated equipment. It gives us a data set, a very valuable data set and at a very, very small cost to this country.

Mr. NELSON. Dr. Masursky, you are the only scientist on the panel today who is a Government employee. Is that correct?

Dr. MASURSKY. Yes.

Mr. NELSON. Does that help or hinder your relationships with the Soviets?

Dr. MASURSKY. Well, it increases the, let's say, bureaucratic fog. It helps in that the U.S. Geological Survey has very close relationships with the Soviets in many other arenas. We both have very strong earthquake prediction programs, and there have been visits by the scientists in both groups. We have had people stay in their field centers near earthquakes that are even more active than San Andreas. We have people who work in Antarctica and who have Soviet colleagues that they have worked with closely. We have had people jointly occupy ice islands in the Arctic Ocean. So it seems perfectly normal to me to have an active exchange. We have marine geology people who visit each other and who trade information.

So it seems, across the scientific spectrum, that I have met many Soviets who have worked with us in other arenas. So it helps in the sense that they understand my organization; they have had much to do with it. I have many colleagues there who work in other fields, and it eases the exchange because we have many friends and colleagues in a variety of fields.

Mr. NELSON. Would any of you like to comment about the Soviet Academy of Sciences being interested in some U.S. experiments in cooperation on their Mars missions to Phobos?

Dr. SIMPSON. I might, and perhaps my colleagues would also like to make some comments. I would like to comment in the following sense, that after the launch of the Halley Comet mission spacecraft, the Director of the Space Research Institute talked to me by telephone and invited the University of Chicago to put experiments on the missions to Phobos.

We were excited about this possibility, but it became very clear in the months of January, February, and March that nowhere in our Government was anybody prepared do to anything to see any further cooperation.

In terms of the science to be achieved, within NASA, yes, there is very strong interest that it would be great science to do, but as I mentioned earlier in my statement, NASA can't really afford, really with their tight budget, to turn around and suddenly another emergency, put up funds for another mission on another new mission. And that's part of the reason for my statement that we need to do something quickly.

Now, the Phobos mission, they offered—the University of Chicago involves two experiments. One was to be on the Phobos lander, using technology that we have at the university that we used to be the first on the Moon and analyze the elemental composition of the Moon's surface. The same instrument, the same technologies are sitting back there and could be used. That's one experiment.

The other one is an experiment that involves the same technology as on the Halley Comet mission on the main spacecraft. These things could all be executed, because they persisted in asking is there any news on whether we can or can't, obviously they are very interested. They are moving ahead.

I think I would confirm what my colleagues say, that clearly they see benefits in cooperation. But clearly, they are not going to sit around forever. They're going to move out, and they are in the process of doing so on the Phobos mission.

They are not lacking in ideas. It's an imaginative idea to be sitting on the mother spacecraft, hover over a moon of another planet, and zap it with a laser beam and let the stuff splatter out and then sit there and analyze it as it flies by. I mean, it's clever. Why didn't we think of it? And we would obviously enhance all of us if we could be on the same mission and learn how they do it and what they learn from it and the pitfalls and everything else. We won't. The way we're going now, we're locked out of it as far as the United States is concerned.

Mr. NELSON. Are there a lot of other countries that are on those missions?

Dr. SIMPSON. Yes. I would be glad to provide a more detailed list, because I have studied this matter in detail. In terms of what's called the Phobos mission, there is France, Sweden, West Germany, Ireland, Holland. Then, of course, in the Soviet sphere, heavy involvement from Hungary, East Germany, Bulgaria, and so forth. It really is international, except the United States is locked out.

Mr. NELSON. Dr. Smith?

Dr. SMITH. Well, I just wanted to state what is the obvious, and that is that if the Soviets cannot work cooperatively with this country, they will turn, and are turning, to Western Europe, and the result of that is that these missions will be carried out. Some very

exciting solar system science will be done, and this country will be locked out of it.

Mr. MASURSKY. I wanted to make a comment because we've discussed the desirability of cross-calibration of instruments, you know, if we can't provide instruments. We did this on the Venus Pioneer and the Venera. We had four instruments, and we got four different answers about atmospheric composition. So we decided it would be nice if we knew what the real answer was. And after endless negotiations, the Bureau of Standards agreed to provide a gas sample to send to the laboratories of each of the investigators.

It took so long to negotiate, and it took so long for the sample to be prepared and get it to all the four investigators, as far as I know, none of them have touched it, because they're all working on other projects now.

So I said, "Well, why don't we, before we fly the Mars Observer and Phobos, cross-calibrate instruments?" And they said, "Good idea." So hopefully, at least we will be able to compare our instrumental results from the large load of instruments that both countries will fly and be able to trust the data better.

I wanted to make one other comment. You see, we talk as though the Soviets are this massive organization and everybody thinks and acts and does just the same. And it is a very long way from the case. My senior professor in graduate school said, "Unfortunately, science has to be done by scientists," and that means that they're prey to all the human virtues and feelings, and the Soviets spend a great deal of time fighting each other.

And I think when you mentioned that you got different answers, we get real different answers, and I have sat with Soviets when one of their guys is giving a talk and this guy is whispering nasty comments in my ear about this guy and how you can't trust any of his results.

So you get very strange answers, and they're very territorial about the data. You see, I talk to them about getting data, and they say, "Well, if it's chemical data and we've flown the experiment, of course, you can have it. But if it's data from the other, then we haven't succeeded in getting any of that ourselves. But when you come to Moscow, I will introduce you to him, and maybe you will have better luck getting something from him than I have had."

But I got a TWIX the other day that they're getting digital data from the Venera 15 and 16, and Kotelnikov has agreed, and they said, "What format do you want the data in?" And I am going there in 3 weeks, and hopefully I will come back with a tape.

Mr. NELSON. And while you're there, why don't you introduce some of their scientists to each other? [Laughter.]

Dr. MASURSKY. That's necessary.

Mr. NELSON. Dr. Simpson, we will just go on and conclude this. You all have been very patient. I guess you're the one that we haven't asked this question to. Do you have a personal opinion about a joint manned mission to Mars?

Dr. SIMPSON. I recognize that setting a distant goal, perhaps even an unattainable goal, sometimes is a way to get moving in an effort. However, I think that there are definite dangers in trying to leap

ahead and trying to establish a manned mission as our goal out there.

You might deduce from my own testimony that I firmly believe that the way to approach this problem is incrementally; that is, work on the level that we've been talking about here around the table today in terms of unmanned missions, step by step, and recognize a very interesting quality of the Soviets. I guess the phrase I use around my lab with my students is, "Don't forget, the Soviets are incrementalists," and what I mean by that is the following. When you look at the way they develop a military vehicle or a tank or anything, if they're coming out with a new tank. Well, what does that mean? It's either got a new tread or they've changed the gun or they've changed something like that. They never come out with a total revolutionary weapon. They always evolve it from what they've already got.

This is a remarkable characteristic that also continues into the space program. The Vega mission spacecraft, which I have scale drawings on on my wall, show that it's a derivative of sputnik, that onboard is one of the telemetry systems that looks as though it hasn't gone much further than Sputnik 3. On the other hand, onboard also has been added a very hot one that's going to be the encounter telemtry system.

They don't see things, they don't move leaping way ahead to some shakey agreement in the future; they like to see things done this way.

The other point I would like to make about the manned mission to Mars is that when you're doing an experiment, one of the things you do is you always outline it all the way to the bitter end, looking for the faults, looking for what I would call the "single point failures" all the way through. And I can imagine very many single-point failures that could be disastrous in any agreement where we involve men onboard a mission going to Mars, not the least of which would be, say, one, one of the astronauts is killed or dies, who is to blame, how did it come about, all the acrimony and so forth.

Or you could take even one that might seem superfluous on the surface, of who is going to be the first to step on the surface of Mars? Is it going to be a Soviet or United States scientist? It may seem to us trivial, but it isn't going to be trivial when one has to figure it out.

What I am trying to say is that there are many things we can do that can greatly expand our exploration of the solar system working together, and competitively, without getting involved in a program at this time that is fraught with so many single-point failures built right into it.

So I think my answer to you is that I see it as a long-range goal, far beyond the ISY that Senator Matsunaga has proposed, and I understand the human feeling that this would be a great thing to do. But I think that both from the way the Soviets think and the way we should operate, I think we ought to try to do things incrementally.

Mr. NELSON. A final question—I promise.

Dr. MASURSKY. May I?

Mr. NELSON. Yes. Surely.

Dr. MASURSKY. A slightly different view. I have worked both with unmanned and manned exploration, and I have worked very intensively on defining places that would return good scientific information from Mars.

As far as I can tell, the choice of a landing point and traverse capability is independent of whteher it's done manned or unmanned. We almost surely would do it incrementally and will start with the Mars Observer that will fly in 1990 to test whether our suppositions about the chemical nature of many of the rock units is correct. But if we choose those points, we might well want to fly an unmanned rover before we fly a manned one.

But Mars' geology is much more complicated than lunary geology, and teaching astronauts how to collect samples from this very complex environment I think would be a much bigger payoff than we received from the moon. And they were invaluable there.

So it seems to me we can do it unmanned, and we can do a very respectable job. We can do a better job with men on the surface. We can go farther, we can go faster, we can do more complicated things. So it's not just the ideal of a manned mission, I think it can be a very concrete reality. And if we set that, we will use different increments than we would if we didn't have that goal.

So I think it's a beautiful goal. I think it can be done, and I think we ought to start with the Mars Observer, and we're going to choose the payload shortly to do the right things with this next spacecraft to build towards a manned Mars mission.

Mr. NELSON. OK. My final question—and this has been most stimulating, and I really appreciate you all participating here—do you have any advice to us, should the invitation be forthcoming to this committee to travel to the Soviet Union along with our three ASTP astronauts, as to what we ought to do, who we ought to see, what we ought to say? I open it to you.

Dr. MASURSKY. Well, I think it would be a good idea because in this kind of thing, symbology is very important. So the fact that you were putting the emphasis on it I think would do nothing but good. I don't see how it could hurt the cause of closer cooperation.

I think it's essential—the Soviets are very formalistic. I find them much more Germanic than they are American. They do things in a very hierarchical fashion, and they lay things out. They don't do things sort of spur of the moment the way we do. We approach problems in a totally different spirit.

But I think if we could arrange the resumption of the agreement, that would be lovely. But this might be a step towards the resumption of that agreement, and I think we will see a much more active exchange. We still have an exchange that goes on now. You have heard our people discuss what has gone on.

So I think anything that helps—even the informal arrangements I think have helped—keep the thought alive that we could do each other good. And I think that would be a beneficial step. And we can talk about particular people, if you would like.

Dr. SIMPSON. I think it would be helpful and valuable on both sides to emphasize that you have had these hearings, that you have this strong support from U.S. scientists and that you are carrying the message to them in this regard. I think this is very important to keep it alive.

Dr. SMITH. Well, I agree as well. I think it's very important to understand what makes the Soviets tick. As Dr. Masursky says, in a sense they are highly structured, but individually and one on one, they are really very much like Americans. They have many of the same fears, many of the same suspicions, and the same hopes for achieving some sort of international cooperation in space and, I suppose, ultimately international cooperation at all levels.

Mr. NELSON. Thank you, gentlemen. Thank you, too, to you two gentlemen. It's been a most productive couple of days.

The meeting is adjourned.

[Whereupon, at 12:35 p.m., the subcommittee was adjourned.]